
**Pacific Northwest
National Laboratory**

Operated by Battelle for the
U.S. Department of Energy

Geologic and Wireline Summaries from Fiscal Year 2002 ILAW Boreholes

S. P. Reidel
A. M. Ho

September 2002



Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY

operated by

BATTELLE

for the

UNITED STATES DEPARTMENT OF ENERGY

under Contract DE-AC06-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>



This document was printed on recycled paper.

(8/00)

Geologic and Wireline Summaries from Fiscal Year 2002 ILAW Boreholes

S. P. Reidel
A. M. Ho

September 2002

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Four boreholes were drilled at the Immobilized Low-Activity Waste Disposal Site in April 2002. Three were completed as groundwater monitoring wells. This report documents the drilling and data collected from the drilling.

Contents

Summary	iii
1.0 Introduction	1
1.1 Boreholes.....	2
1.2 Technical Objectives	2
1.3 Report Organization	3
2.0 ILAW Drilling and Sampling Activities.....	3
2.1 Drilling and Well Construction	4
2.2 Sampling	4
2.3 Aquifer Testing	5
2.4 Geophysical Logging	6
3.0 Borehole Stratigraphy.....	6
3.1 Ringold Formation	6
3.2 Hanford Formation.....	6
3.2.1 Lower Gravel Sequence	24
3.2.2 Sand Sequence.....	24
3.2.3 Paleosols.....	26
3.2.4 Clastic Dikes	27
3.3 Passive Gamma Spectral Results	27
4.0 Groundwater Chemistry	28
5.0 Conclusions	28
6.0 References	29
Appendix A – Well Summary Report for 2002 ILAW Well Installations.....	A.1
Appendix B – Description of Core from Borehole C3826	B.1
Appendix C – Description of Core from Borehole C3827	C.1
Appendix D – Description of Core from Borehole C3828	D.1
Appendix E – Geophysical Logging.....	E.1

Figures

1	Location Map Showing the ILAW Site and Boreholes	1
2	Location of Boreholes Drilled at the ILAW Site.....	5
3	Stratigraphy Across the ILAW Site Based on Pre-FY 2002 Data.....	7
4	Summary of the Stratigraphy and Lithology of Borehole C3826.....	8
5	Summary of the Stratigraphy and Lithology of Borehole C3827.....	12
6	Summary of the Stratigraphy and Lithology of Borehole C3828.....	16
7	Summary of the Stratigraphy and Lithology of Borehole C3926.....	20
8	Basal Gravel from Borehole C3826 at the ILAW Site.....	25
9	Sand-Dominated Unit from Borehole C3826, 60.0-61.0 Feet, at the ILAW Site.....	26
10	Paleosol from Borehole C3826, Depth 30.5-31.5 Feet.....	27
11	Clastic Dike Penetrated in Borehole C3828	28

Tables

1	Boreholes Drilled at ILAW Site During FY 2002.....	2
2	Intervals Selected for Continuous Coring.....	3
3	Borehole Locations and Depths.....	4
4	Thickness and Depth of the Hanford Formation Encountered in Boreholes.....	24
5	Summary of the Geology and Lithology of Boreholes C3826, C3827, C3828, and C3926.....	25
6	Groundwater Chemistry	29

1.0 Introduction

The U.S. Department of Energy Office of River Protection is responsible for safe underground storage of liquid waste from previous Hanford Site operations, the storage and disposal of immobilized tank waste, and closure of underground tanks. The current plan is to dispose of immobilized low-activity tank waste (ILAW) in the south-central part of the 200 East Area (Figure 1).

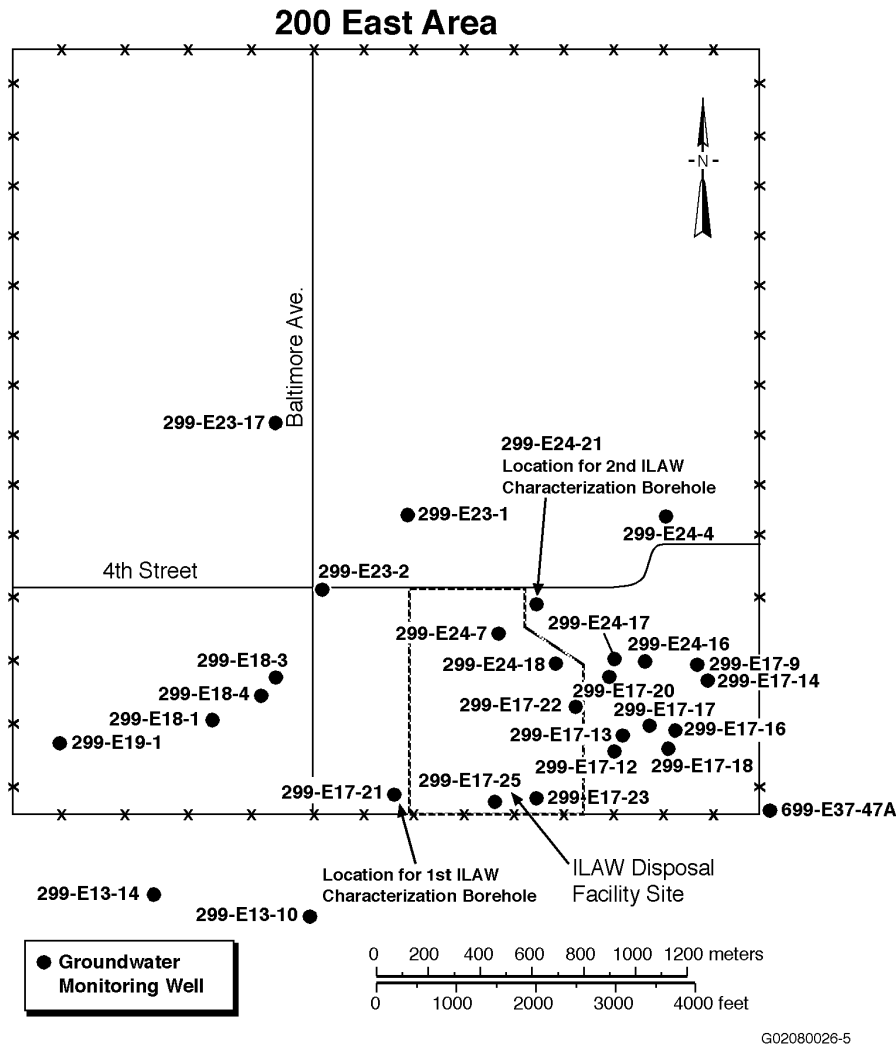


Figure 1. Location Map Showing the ILAW Site and Boreholes

This report summarizes the results of FY 2002 drilling, geologic logging of cores, geophysical logging of the boreholes and preliminary groundwater chemistry from the wells. The drilling and testing activities associated with the boreholes were done in accordance with the Characterization Plan (Reidel 2002).

This report uses the English system of units where discussing drill depth, as it is customary to report borehole depth data in feet rather than meters. Multiply feet by 0.3048 to convert to meters. All other measurements are in metric units.

1.1 Boreholes

Four boreholes (Table 1) were drilled along the south and east sides and at the southeast corner of the ILAW site (Figure 1) in April 2002 in support of the Performance Assessment (PA) activities, to establish a groundwater-monitoring network, and to help establish a pre-operational environmental baseline (Mann et al. 2001; Horton et al. 2000). Three of these boreholes were then completed as groundwater monitoring wells. Walker (2002) provides a summary report of all field activities including drilling and well construction (see Appendix A).

Table 1. Boreholes Drilled at ILAW Site During FY 2002

Borehole Number	Well Name
C3826	299-E17-22
C3827	299-E17-23
C3828	Decommissioned
C3926	299-E17-25

Three of the four boreholes were completed as groundwater monitoring wells (Table 1). Borehole C3828 was drilled and then decommissioned when a measurement critical to insure proper placement of the silica sand pack around the well screen could not be made (Walker 2002). Borehole C3926 was drilled approximately 3 m west of borehole C3828 and completed as a groundwater monitoring well.

1.2 Technical Objectives

The technical objectives of the boreholes were:

- To provide geologic samples to characterize the sediments in the vadose zone in support of the ILAW Performance Assessment and the pre-operational monitoring plan (Horton et al. 2000). This includes physical, hydrologic, and geochemical characterization.
- To install groundwater monitoring wells to establish a pre-operational groundwater baseline.

The primary factor dictating the location of the boreholes was their characterization function with respect to developing the geohydrologic model for the site in support of the PA (Mann et al. 2001), satisfying associated Data Quality Objectives (Reidel et al. 1995; Reidel 2002 [Appendix C, Section 3.2]) and providing information for pre-operational environmental baseline characterization (Horton et al. 2000).

1.3 Report Organization

This report consists of six chapters and five appendices. The first chapter is the introduction and background for the project. Chapter 2 provides a summary on the drilling and sampling methods that were used. Chapter 3 summarizes the borehole stratigraphy. Chapter 4 contains a brief discussion on the groundwater chemistry, Chapter 5 a summary and conclusions, and Chapter 6 lists cited references. The well summary report of Walker (2002) is reproduced in Appendix A, and Appendices B, C, and D contain core descriptions. A summary of the geophysical logging is found in Appendix E.

2.0 ILAW Drilling and Sampling Activities

Drilling, sampling, and well construction objectives for the project are presented in Reidel (2002). That report called for drilling and sampling of three boreholes to be constructed as groundwater monitoring wells. Continuous sample retrieval from selected intervals was needed to achieve the goals of the sampling plan (Table 2).

Table 2. Intervals Selected for Continuous Coring (Reidel 2002)

Depth (ft bgs)	Borehole			Physical Properties	Recharge Tracers	Aquifer Study
	C3826	C3827B	C3828			
8-48	X			X	X	
54-58		X	X	X	X	
58-62	X	X	X	X	X	
62-66		X	X	X	X	
64-68	X			X	X	
68-72	X			X	X	
72-76	X			X	X	
76-80	X	X		X	X	
96-100	X	X		X	X	
120-124	X	X		X	X	
150-154	X	X		X	X	
154-158		X	X	X	X	
158-162		X	X	X	X	
162-166		X	X	X	X	
164-168	X			X	X	
168-172	X					
172-176	X			X	X	
180-184	X	X				
220-224	X	X				

2.1 Drilling and Well Construction

The details of drilling, well construction, and well development are documented in Walker (2002); surveyed borehole locations and depths are given in Table 3 and Figure 2. In summary, the boreholes were drilled in April 2002 using the Becker Hammer drilling method from the surface into the saturated zone.

Table 3. Borehole Locations and Depths (from Walker 2002 and Appendix A)

Borehole Number	Well Name	East ^(a,b) (m)	North ^(a,b) (m)	Elevation ^(a,b) (m)	Water Table ^(b) (ft bgs)
C3826	299-E17-22	574841.067	135195.921	220.589	321.82
C3827	299-E17-23	574694.485	134842.766	223.843	332.5
C3828	Not Applicable	574518.125	134845.545	224.801	341.3
C3926	299-E17-25	574515.171	134845.913	225.028	337.67
(a) Brass cap.					
(b) From Walker (2002).					

The boreholes were completed as Resource Conservation and Restoration Act groundwater-monitoring wells. Each well has a 4-in diameter stainless steel casing and a 35-ft long stainless steel, continuous wire wrap, 20-slot (0.020-in.) screen. A protective casing with locking cap, a cement pad, and protective posts were installed to complete the surface installations.

The wells were developed in May 2002 with a 3-hp submersible pump used at two depths. Water was pumped at a rate of 13 (299-E17-22), 11 (299-E17-23), and 12 (299-E17-25) gallons per minute; there was no measurable drawdown (Walker 2002; Appendix A). Groundwater samples were taken at the end of well development for analysis of selected parameters (see Chapter 4).

2.2 Sampling

Walker (2002; Appendix A) described the field sampling activities associated with drilling the boreholes. Briefly, split-tube samples were collected in 4-in diameter, 1 ft- (C3826 and C3827) or 2 ft- (C3828) long lexan liners. Table 2 summarizes the intervals collected. No split-spoon samples were collected from C3926 because it was only about 3 m west of C3828. Grab samples were collected every 5 ft from all four boreholes for archive purposes.

End caps were taped to each lexan liner, and then the liners were double-bagged in plastic and placed in ice chests with an additional layer of plastic between the samples and the ice for transportation to the laboratory. Samples were transported under chain-of-custody and stored in refrigerators in the 3720 Building until they were opened for examination.

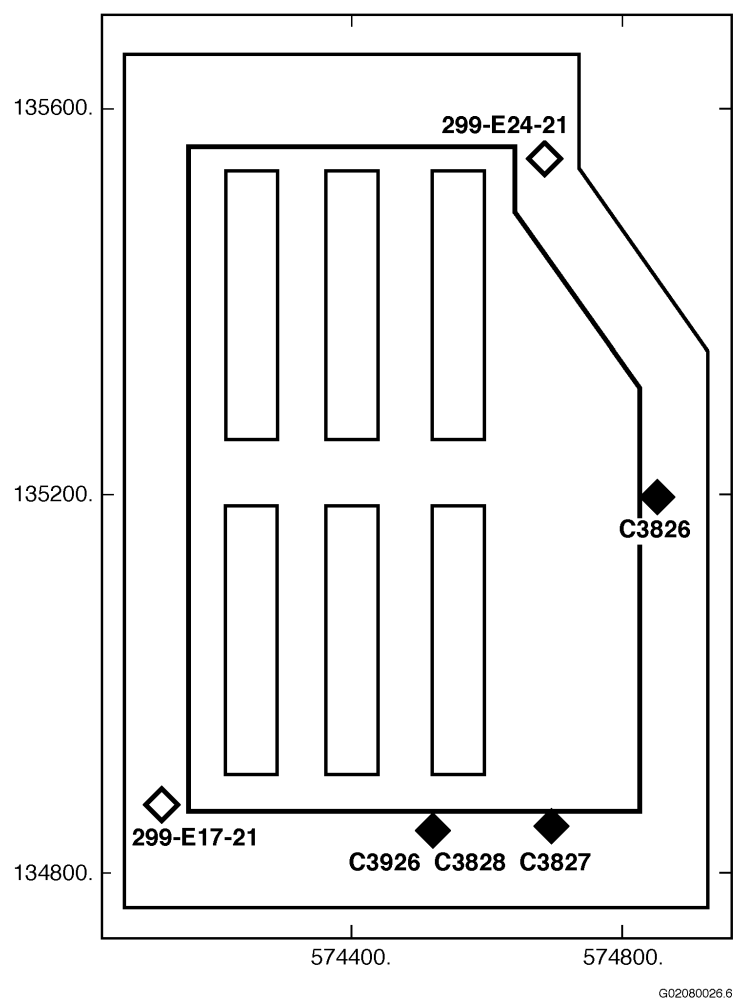


Figure 2. Location of Boreholes Drilled at the ILAW Site

The lexan liners containing the cores from the boreholes were split open in the laboratory and logged following the approved test plan (Reidel 2002). Each sample was photographed, and detailed geologic descriptions made in the laboratory included geologic structure, grain-size, grain shape, sorting, color, moisture, cementation, hardness, and reaction to HCl (see Appendices B, C, and D). Sample liners were resealed with tape after examination and will be archived in the Hanford Geotechnical Sample Library.

2.3 Aquifer Testing

The Sampling and Analysis Plan (Reidel 2002) outlined a testing program for the hydrologic properties of the well. This testing was designed to provide information on recovery rates, effective permeability and other hydrologic properties for the zone in which the aquifer was screened. Testing was done in August 2002 and consisted of slug withdrawal tests. Results of the analyses will be reported separately.

2.4 Geophysical Logging

The boreholes were geophysically logged in August 2002. High-purity germanium logging was conducted to determine the presence of man-made gamma emitting radioisotopes, and to provide analysis of naturally-occurring potassium, thorium, and uranium for stratigraphic studies. Appendix E contains copies of the log suite and the logging analysis report. No man-made radioactive materials were detected

3.0 Borehole Stratigraphy

The boreholes penetrated sediments comprising the Hanford formation and possibly the Ringold Formation in C3828 and C3926. The main elements of the stratigraphy around the ILAW site are shown in Figures 3 through 7. Appendices B, C, and D present a description of the individual cores as they were opened. The well-site geologist's descriptions (Walker 2002; Appendix A) are in good agreement with the lithology and stratigraphy observed in the core. Small-scale features that generally are destroyed during drilling are well preserved in the core, thus allowing a better understanding of the site.

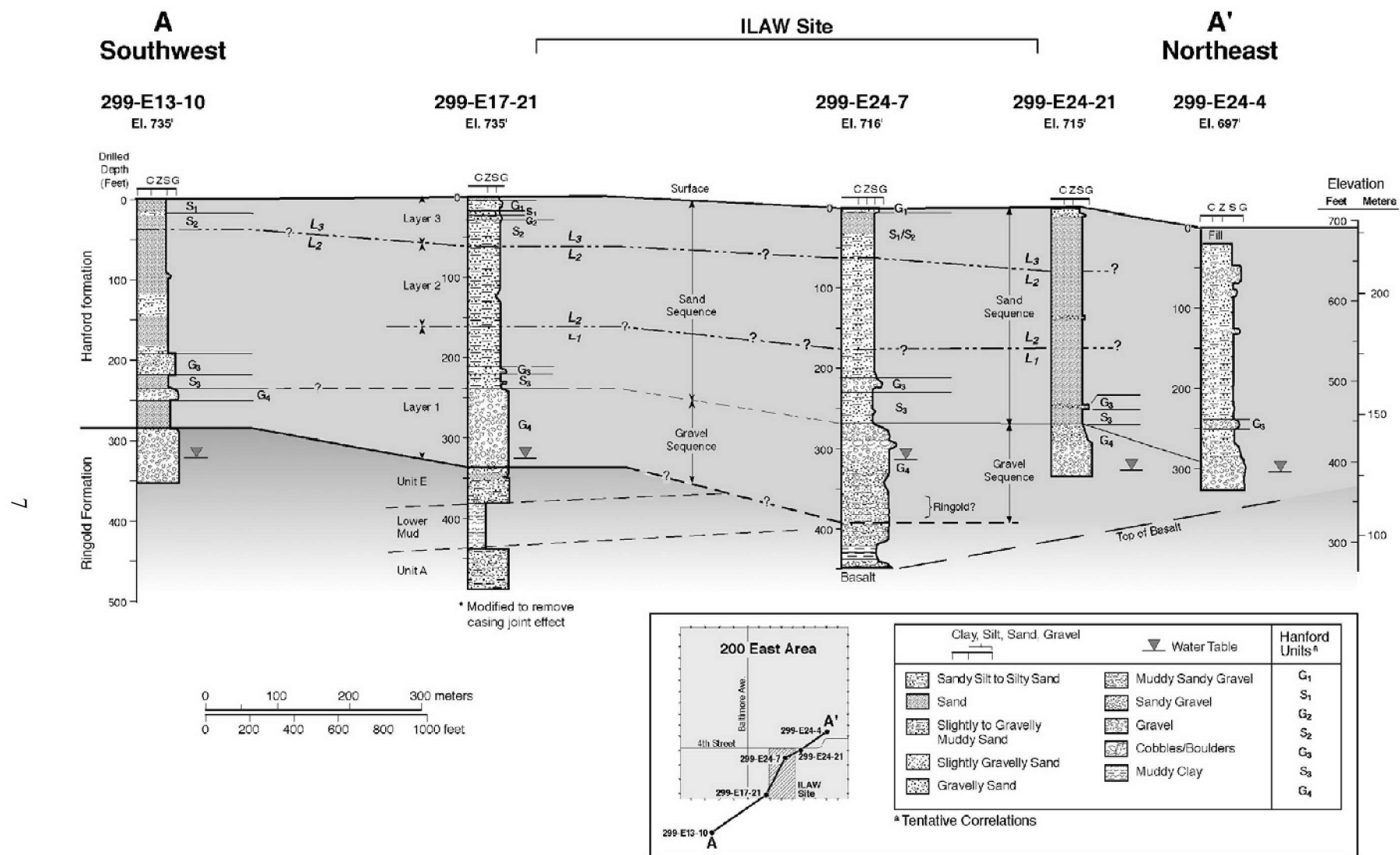
The stratigraphic nomenclature used in this report is consistent with the standardized nomenclature used for the Hanford Site (i.e., Delaney et al. 1991; Reidel et al. 1992; Lindsey et al. 1994; DOE 2002) and with that used in the description of the sediments encountered in the first two ILAW boreholes (299-E17-21 and 299-E24-21; Reidel et al. 1998, 2001).

3.1 Ringold Formation

The Ringold Formation may have been encountered in boreholes C 3828 and C3926 (Figures 3 and 7) based on the well-site geologists logging of the cuttings. Identification of the Ringold Formation is difficult using drill cutting at the ILAW site because of the similarity of the lithologies of the Hanford formation and the Ringold Formation in that area. The amount of water produced by the formations and the presence of cementation are two criteria that can help distinguish the two.

3.2 Hanford Formation

The thickness and depths of the Hanford formation encountered in the boreholes is given in Table 4. The entire thickness of the Hanford formation at boreholes C3826 and C3827 is not known because these boreholes did not penetrate the underlying Ringold Formation. The Hanford formation consists of pebble to cobble conglomerate and fine- to coarse-grained sand with a few interbedded, thin silt and/or clay beds. It is divided at the ILAW site into a lower gravel and an overlying sand unit with sparse gravel layers.



G01110066.3

Figure 3. Stratigraphy Across the ILAW Site Based on Pre-FY 2002 Data

C3826 (299-E17-22)

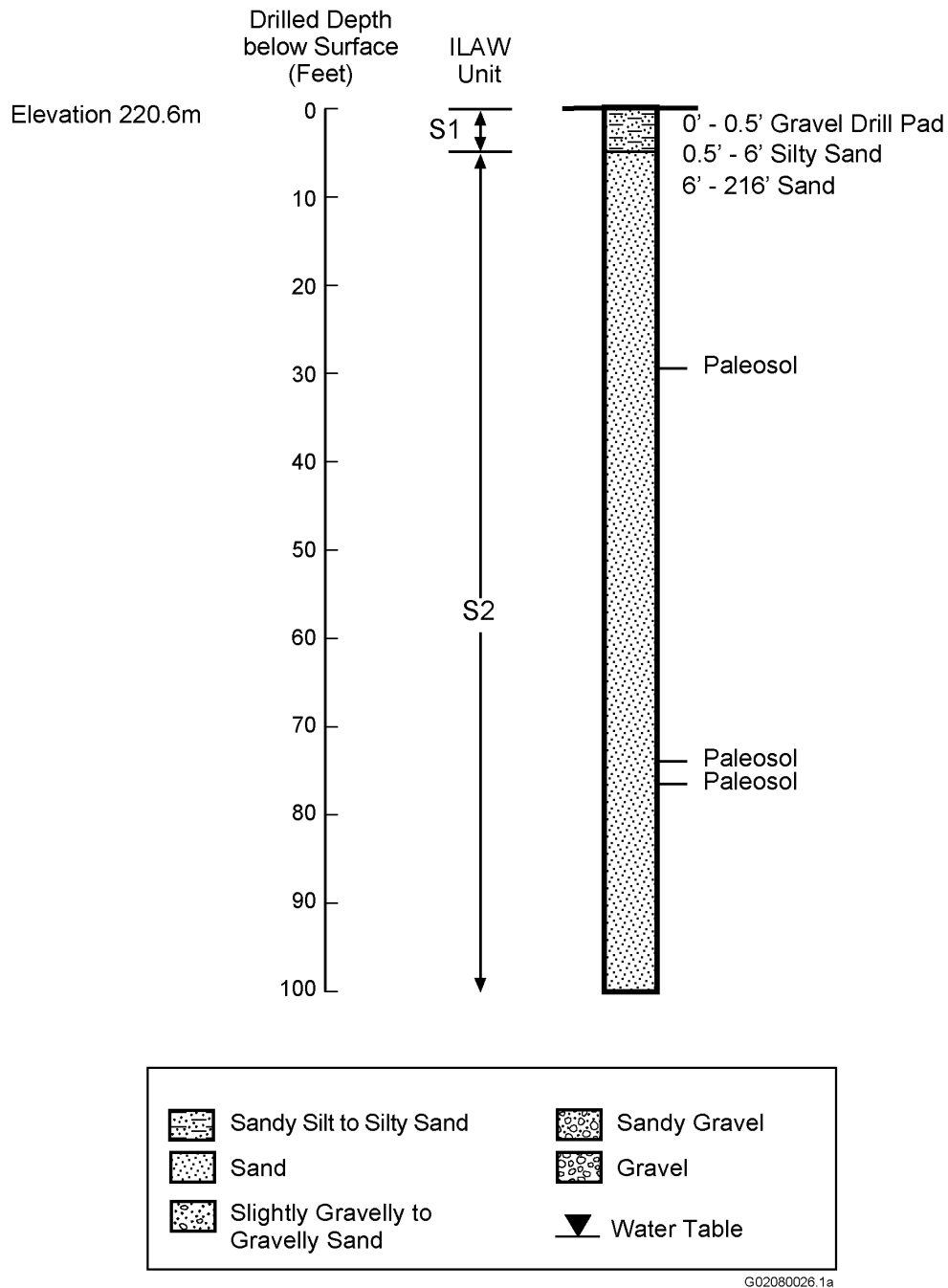
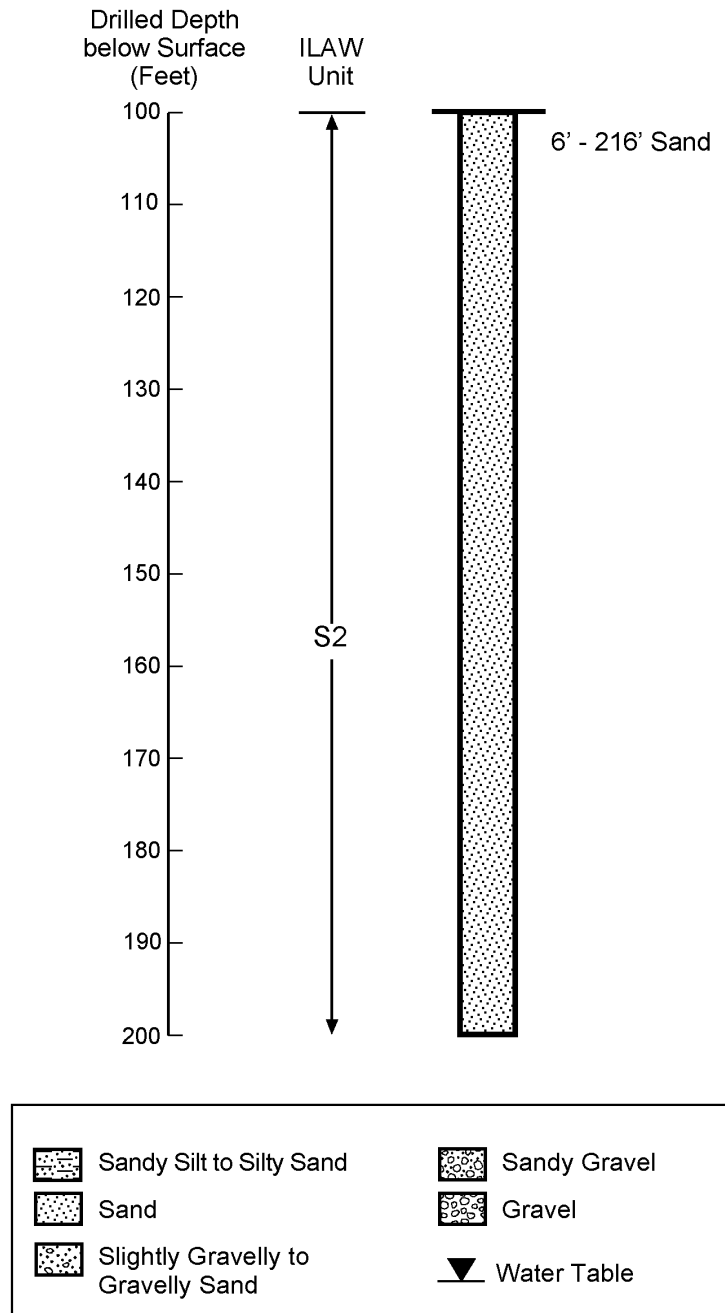


Figure 4. Summary of the Stratigraphy and Lithology of Borehole C3826. ILAW unit refers to sand layers (S) and gravel layers (G) previously observed at the ILAW site. Also see Figure 3.

C3826 (299-E17-22)



G02080026.1b

Figure 4. (contd)

C3826 (299-E17-22)

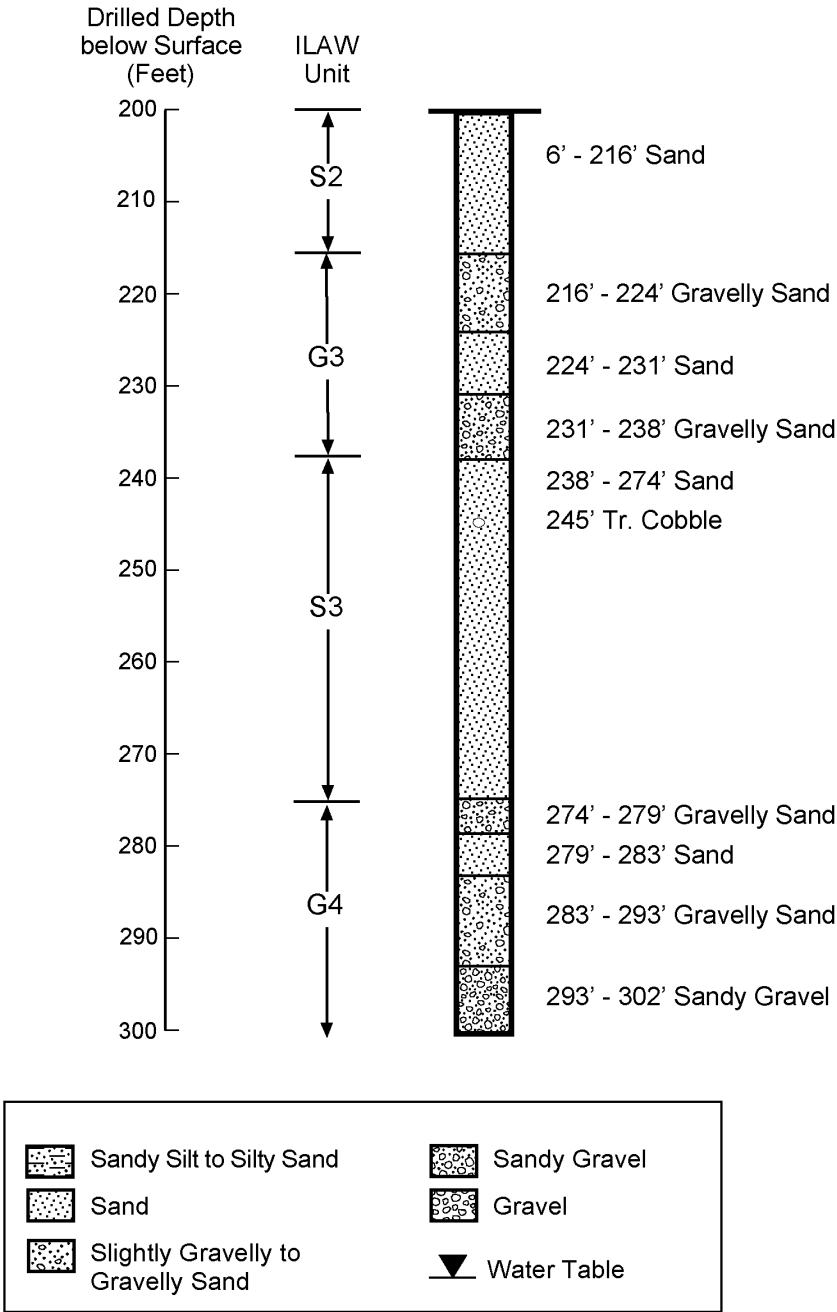
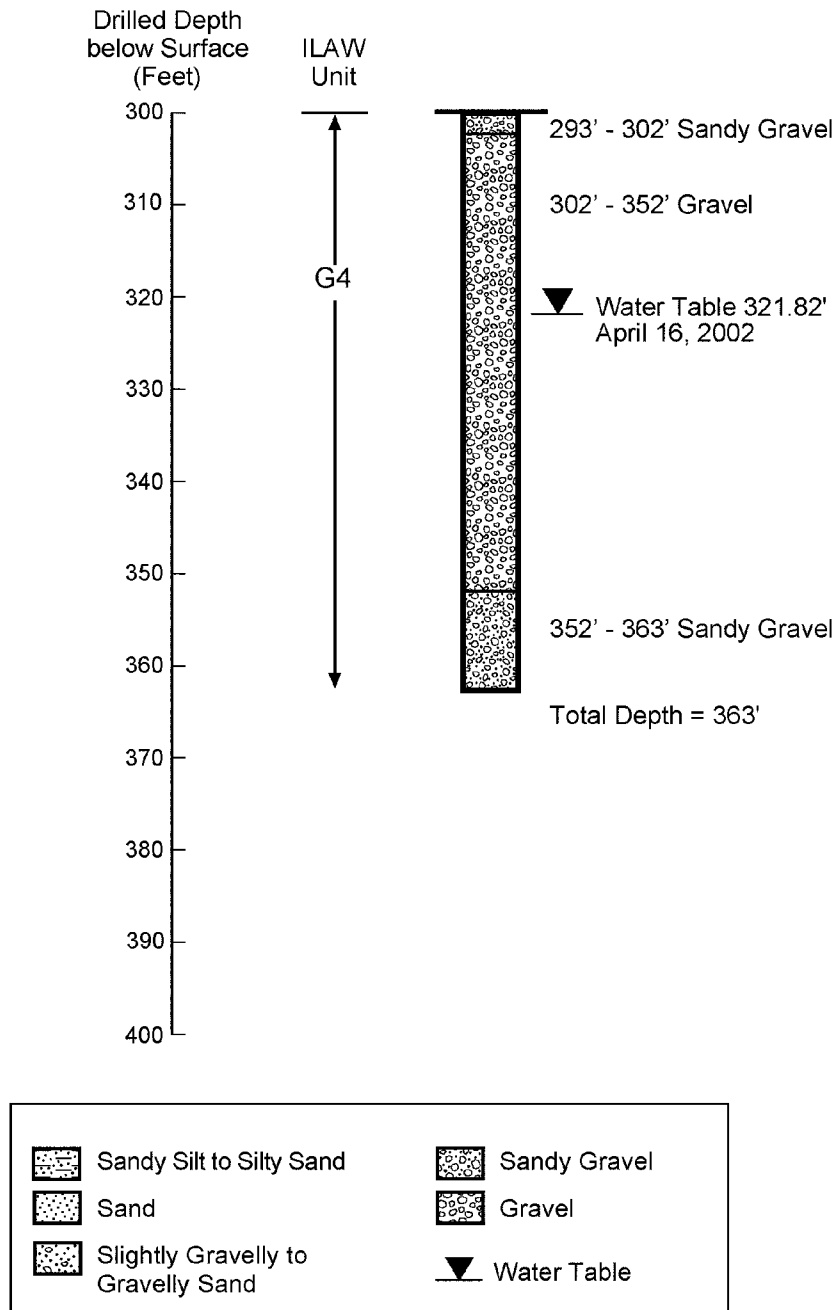


Figure 4. (contd)

C3826 (299-E17-22)



G02080026.1d

Figure 4. (contd)

C3827 (299-E17-23)

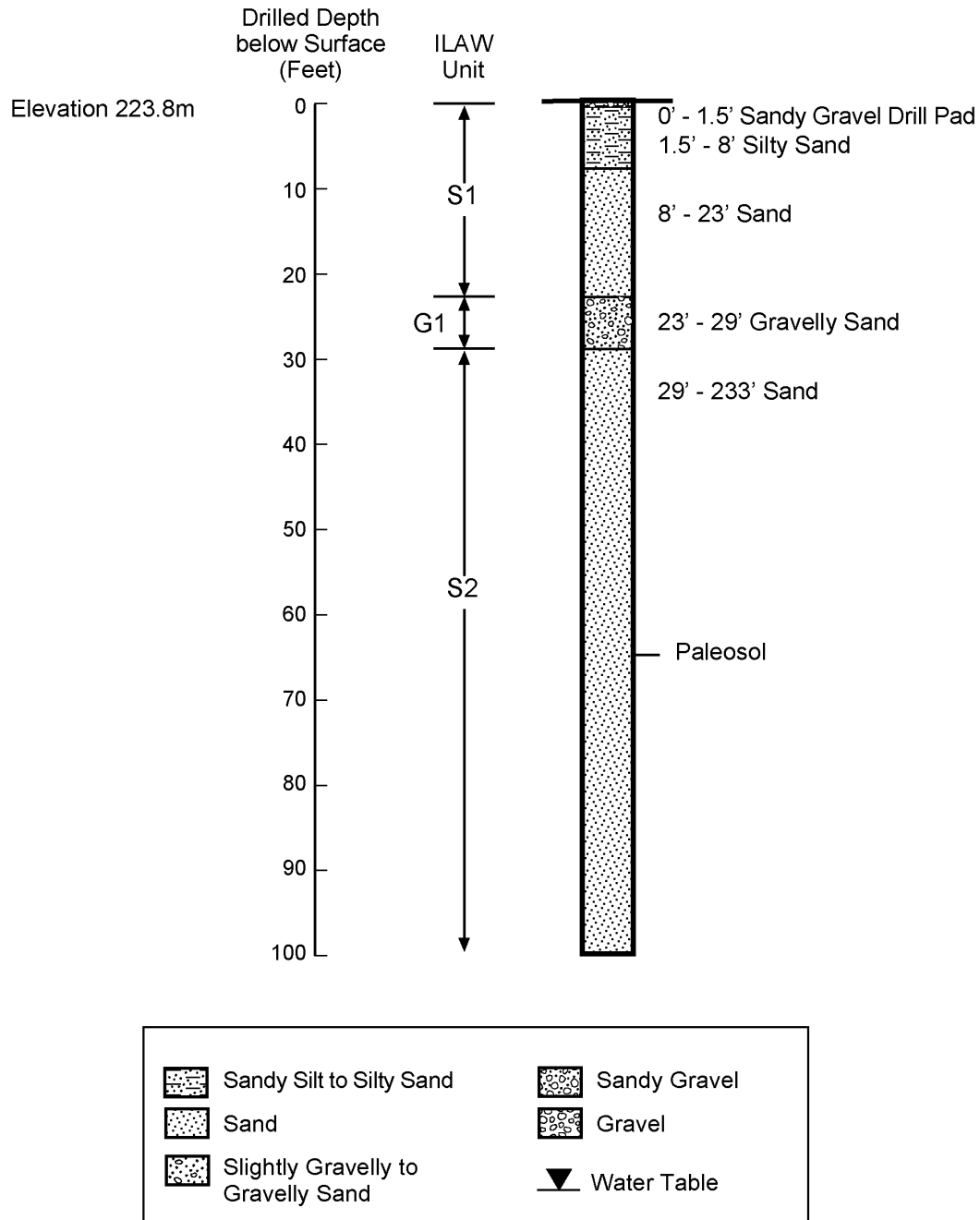


Figure 5. Summary of the Stratigraphy and Lithology of Borehole C3827. ILAW unit refers to sand layers (S) and gravel layers (G) previously observed at the ILAW site. Also see Figure 3.

C3827 (299-E17-23)

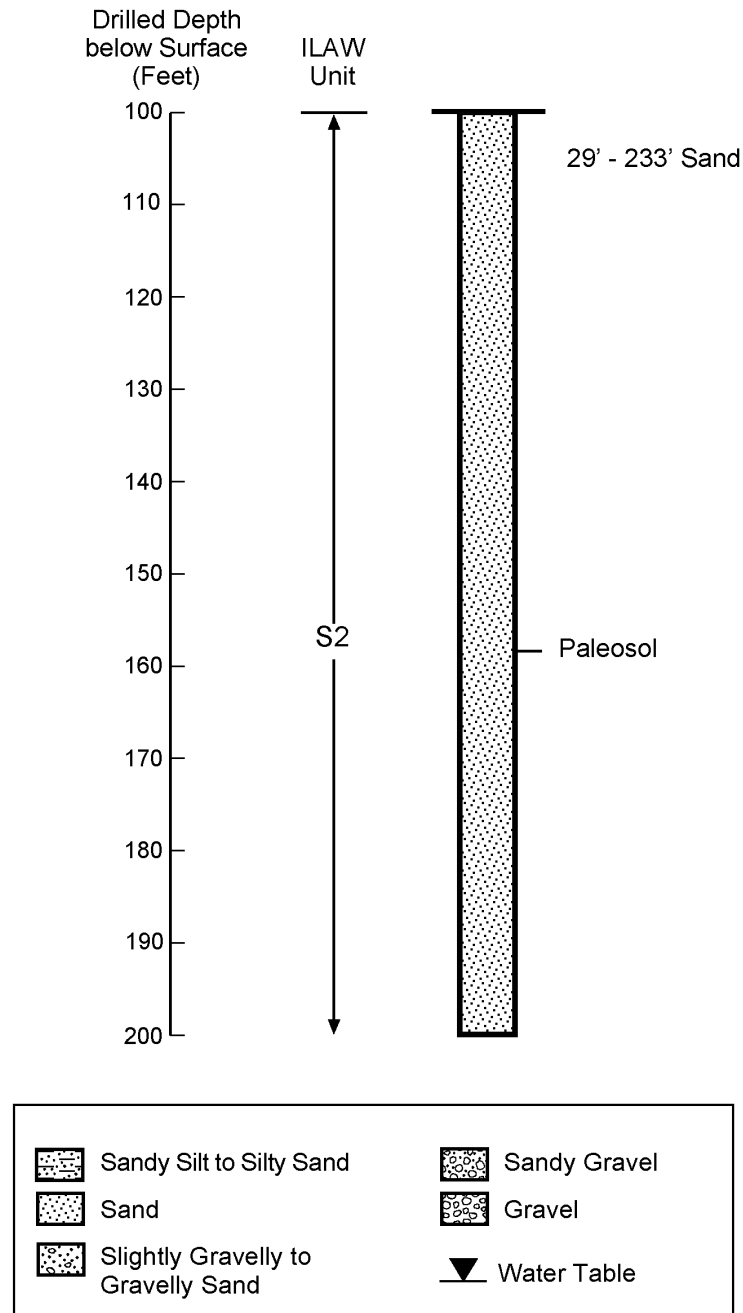
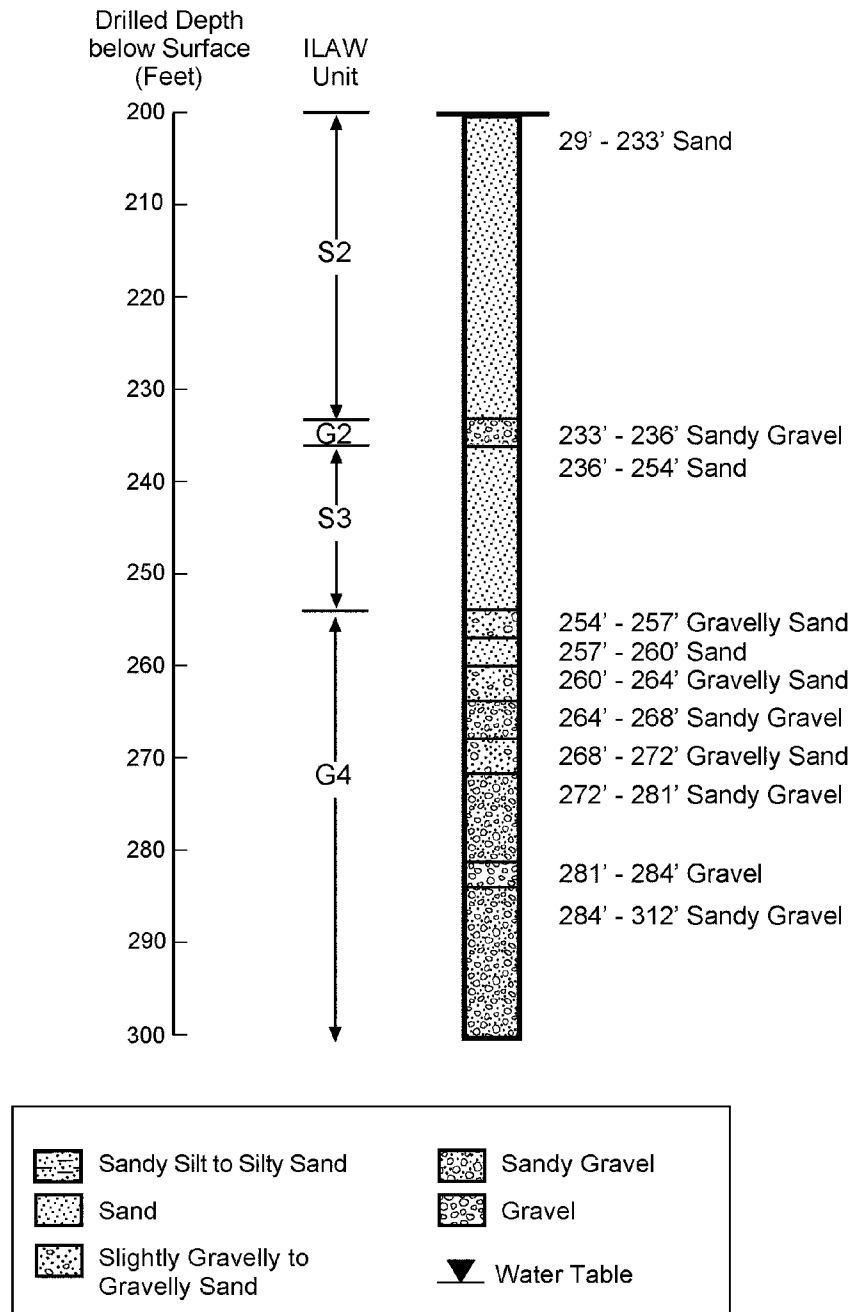


Figure 5. (contd)

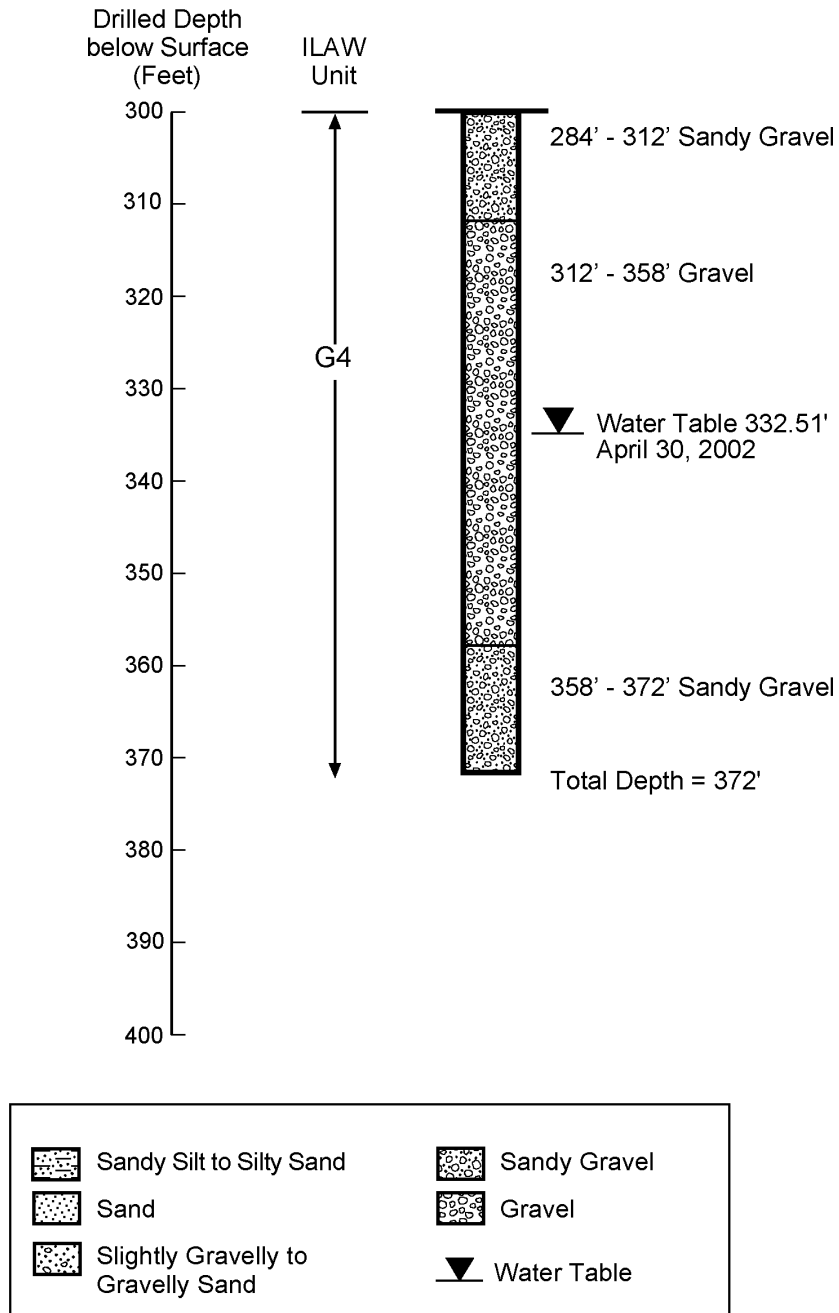
C3827 (299-E17-23)



G02080026.2c

Figure 5. (contd)

C3827 (299-E17-23)



G02080026.2d

Figure 5. (contd)

C3828

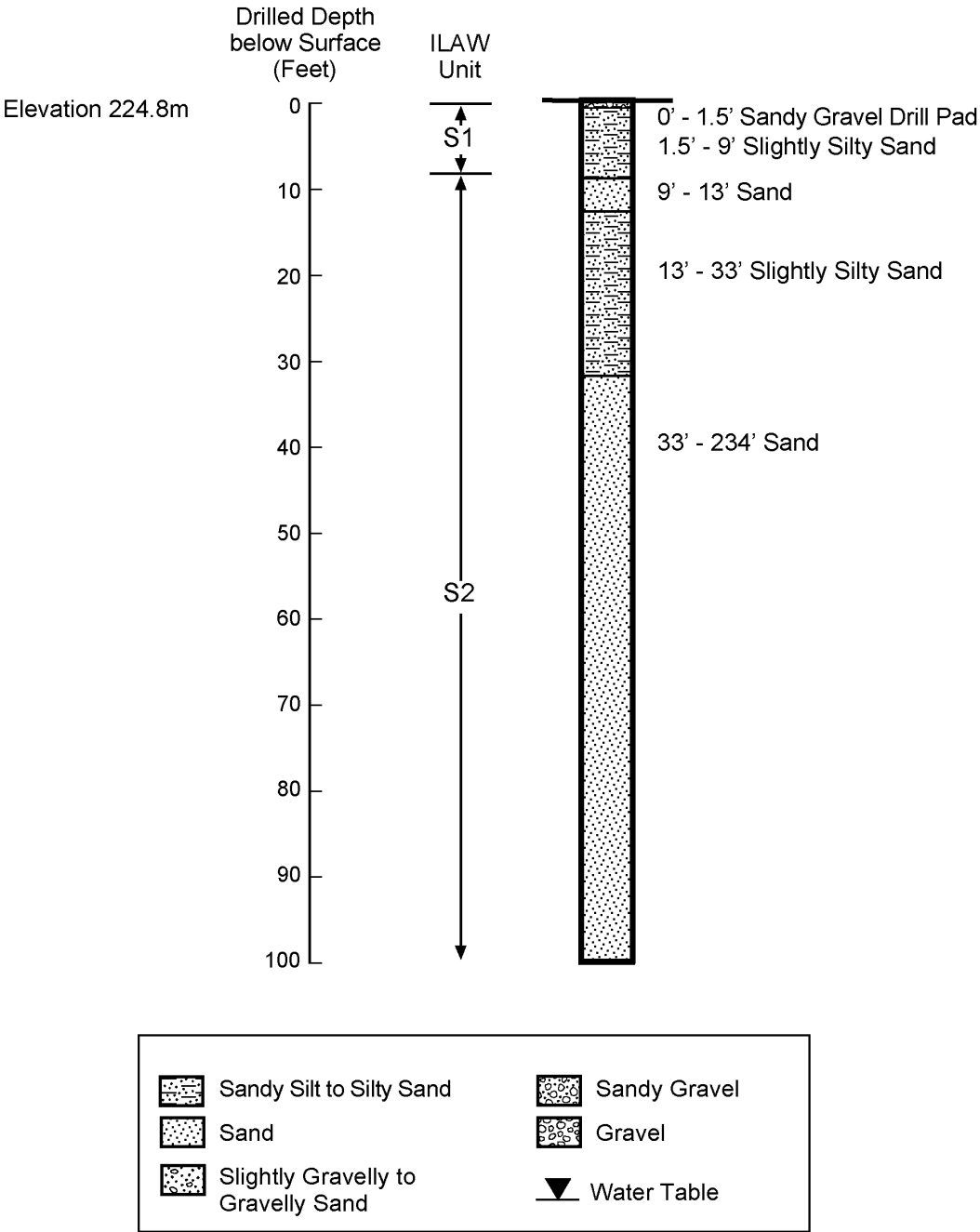
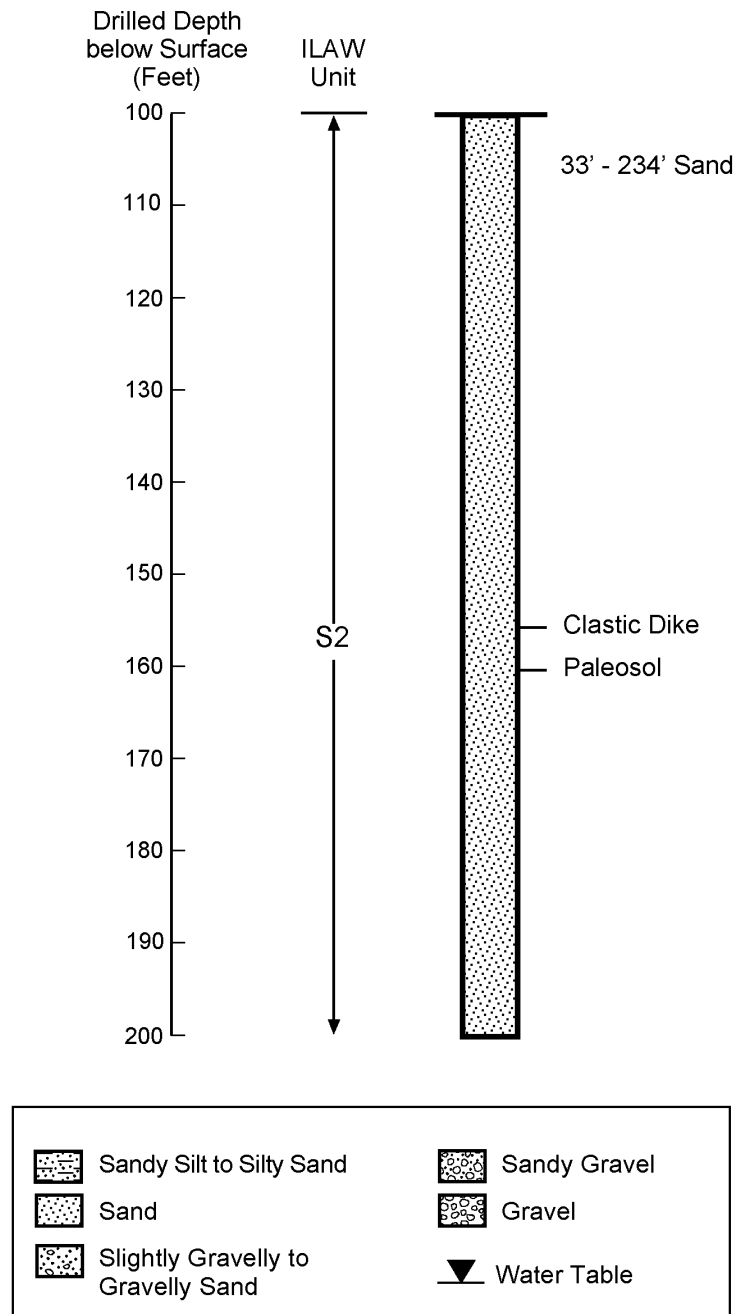


Figure 6. Summary of the Stratigraphy and Lithology of Borehole C3828. ILAW units refers to sand layers (S) and gravel layers (G) previously observed at the ILAW site. Also see Figure 3.

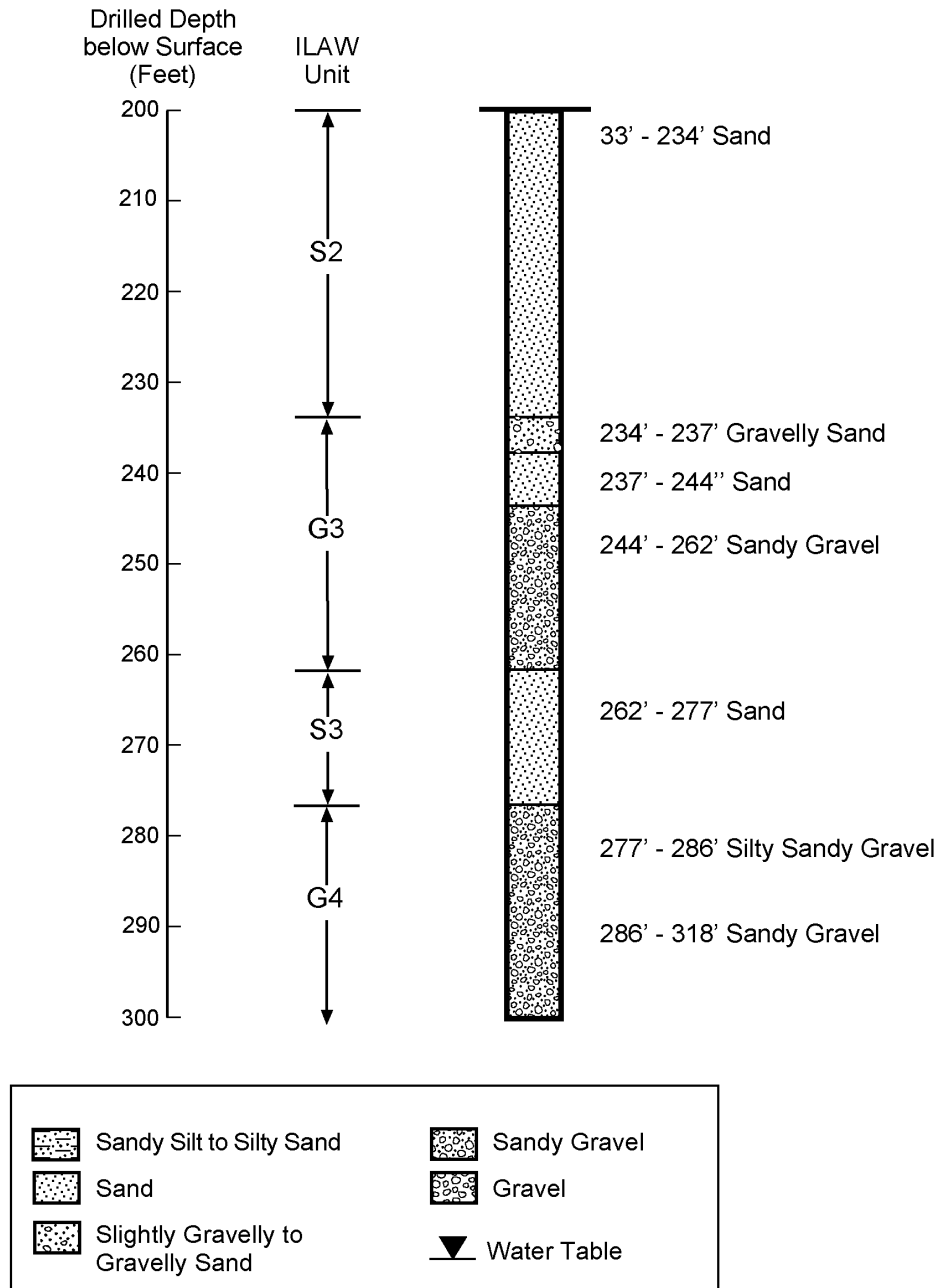
C3828



G02080026.3b

Figure 6. (contd)

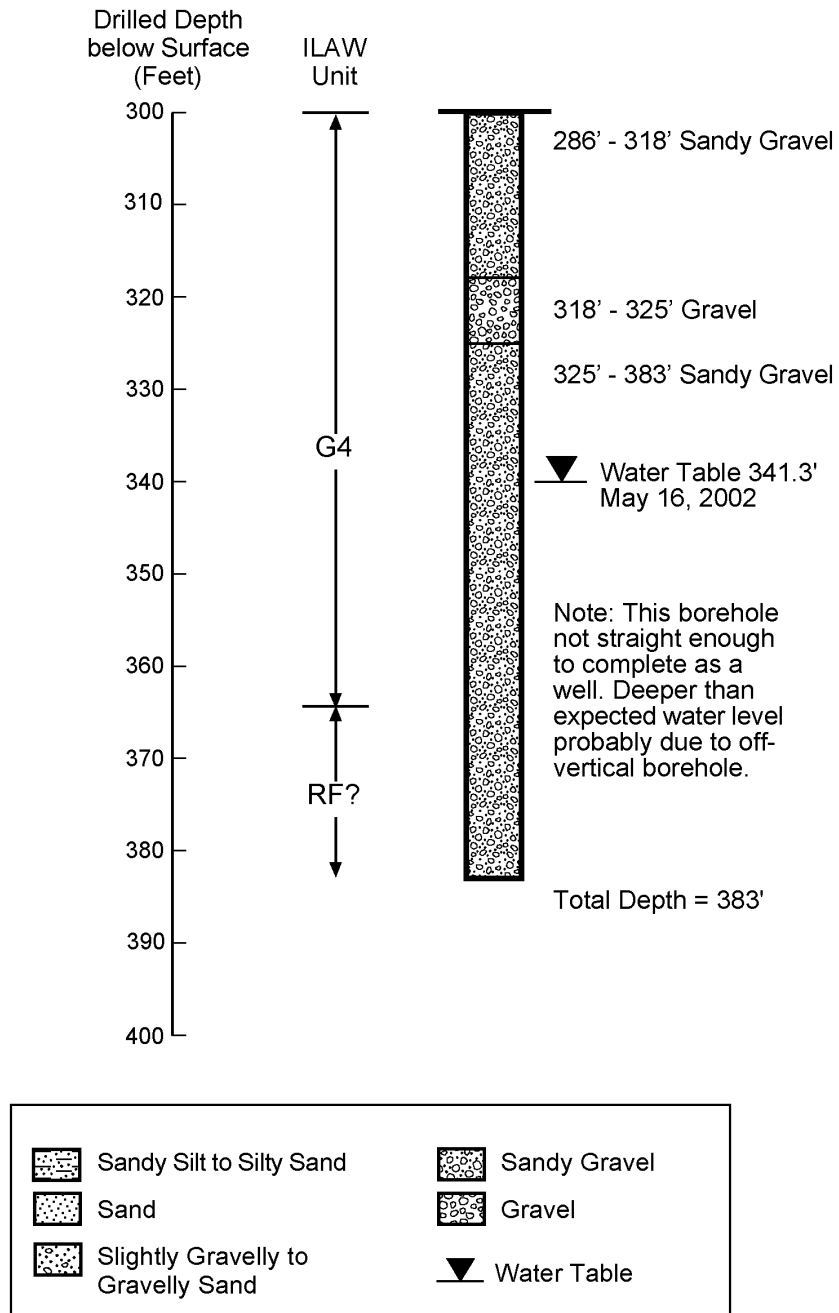
C3828



G02080026.3c

Figure 6. (contd)

C3828



G02080026.3d

Figure 6. (contd)

C3926 (299-E17-25)

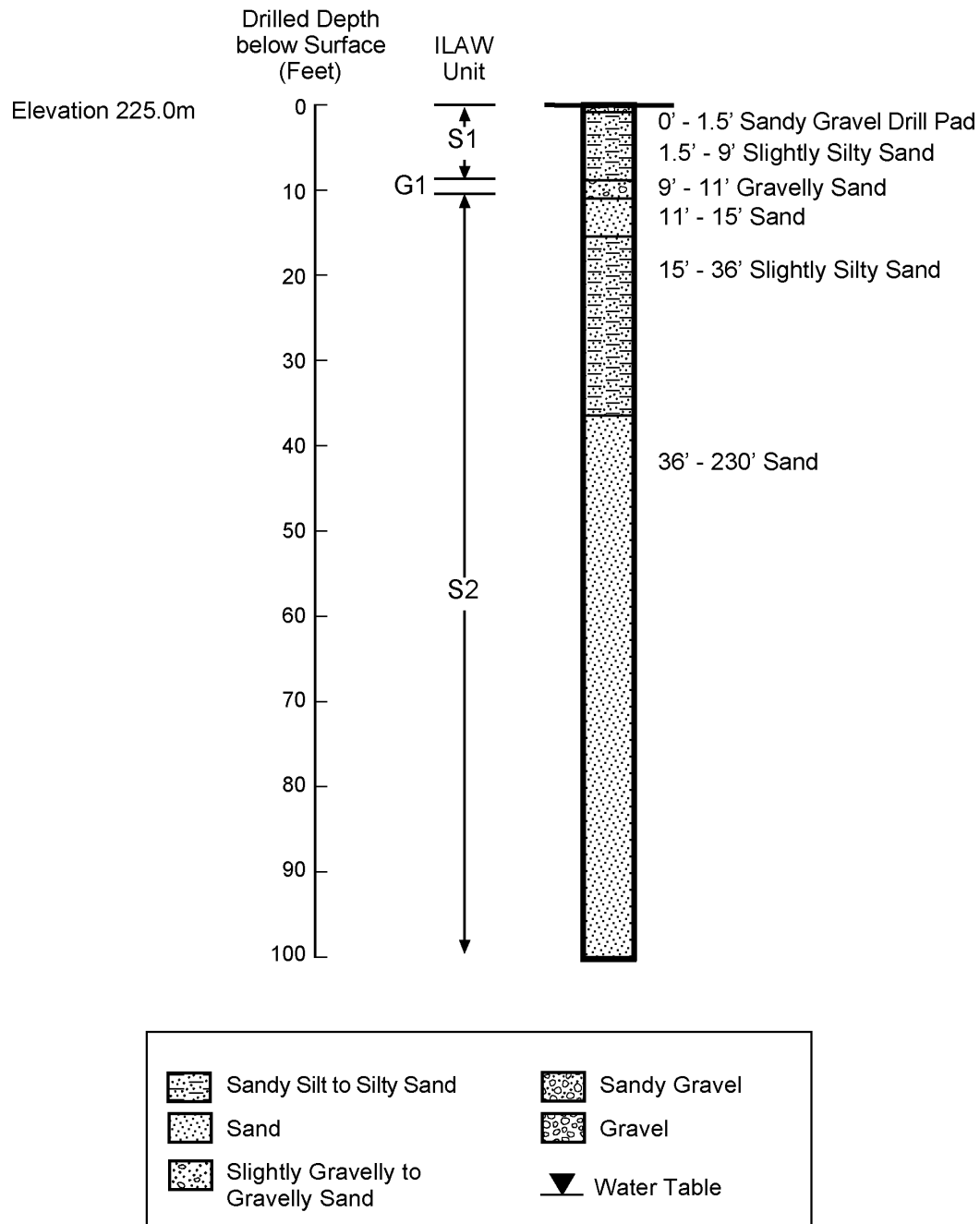
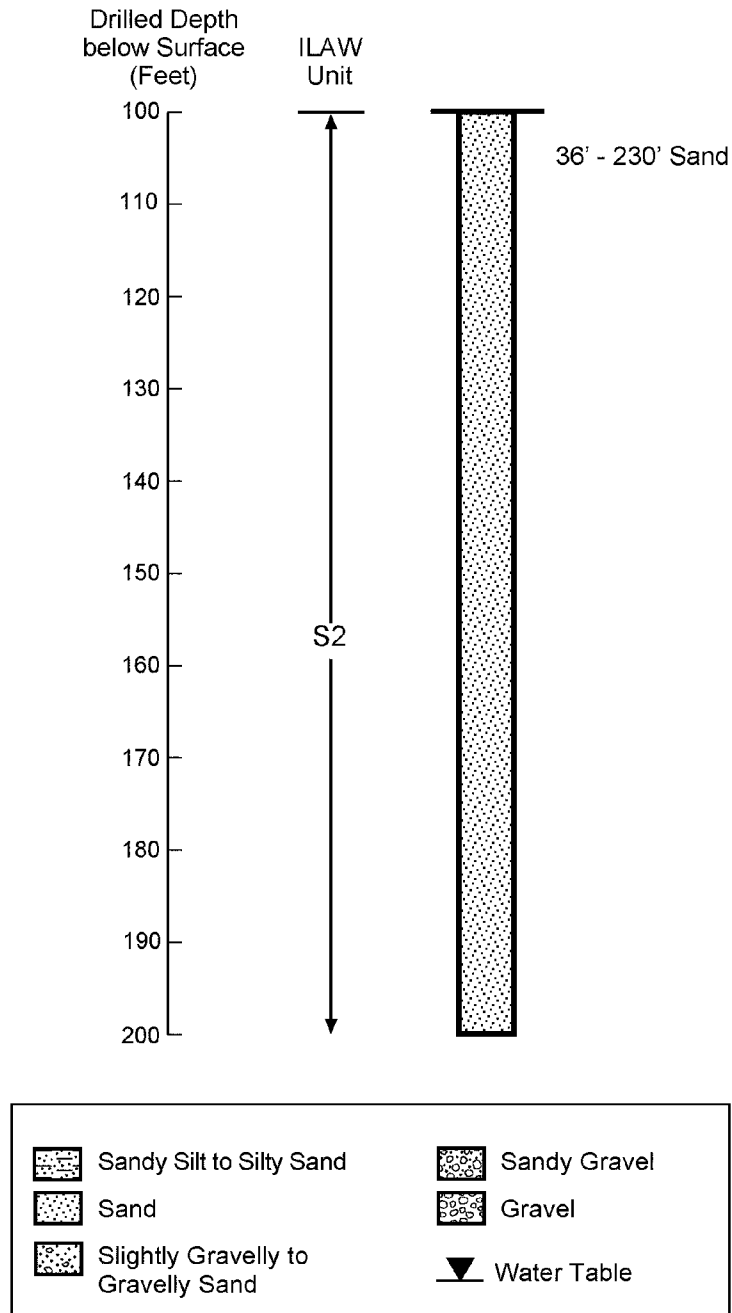


Figure 7. Summary of the Stratigraphy and Lithology of Borehole C3926. ILAW units refers to sand layers (S) and gravel layers (G) previously observed at the ILAW site. Also see Figure 3.

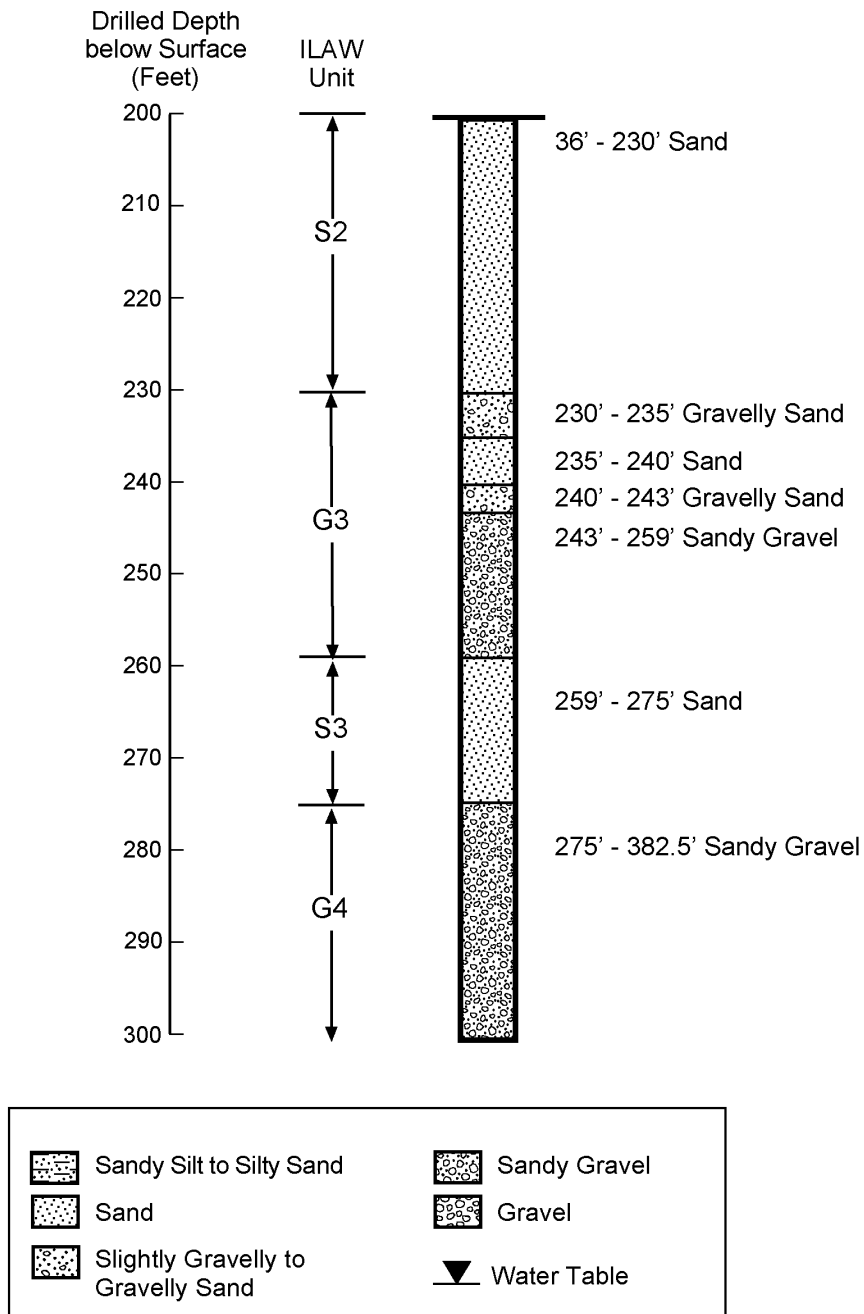
C3826 (299-E17-25)



G02080028.4b

Figure 7. (contd)

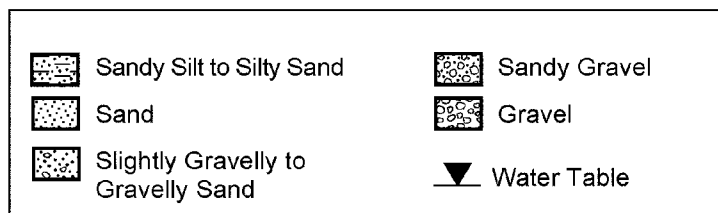
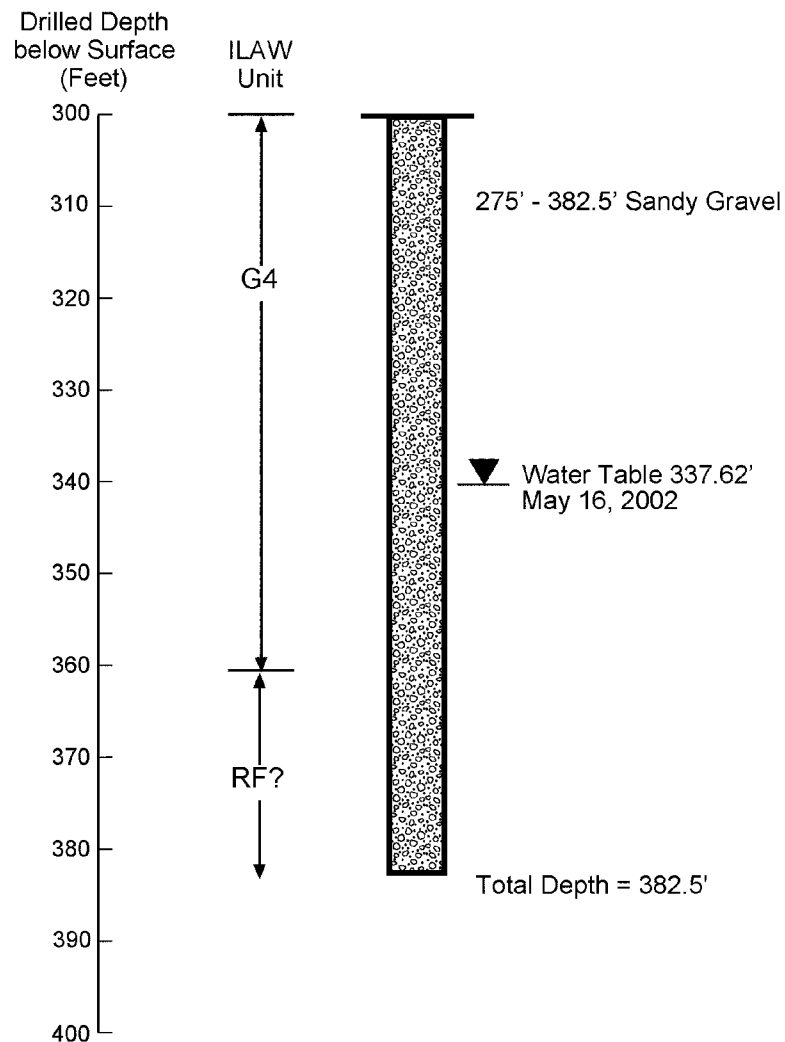
C3826 (299-E17-25)



G02080026.4c

Figure 7. (contd)

C3826 (299-E17-25)



G02080026.4d

Figure 7. (contd)

Table 4. Thickness and Depth of the Hanford Formation Encountered in Boreholes

Borehole	Top of Hanford Formation (ft bgs)	Base of Hanford Formation (ft bgs)	Thickness of Hanford Formation (ft)	Thickness of Ringold Formation (ft)
C3826	0	>363 (TD)	>363	Not Known.
C3827	0	>372 (TD)	>372	Not Known.
C3828	0	~365	~365	>18
C3926	0	~360	~360	>22.5

3.2.1 Lower Gravel Sequence

A basal conglomerate (Figure 8) is present in all four boreholes (G4 in Table 5; Reidel and Horton 2000). This is consistent with the first and second ILAW boreholes (299-E17-21 and 299-E24-21, respectively). The upper part of the conglomerate consists of sandy gravel with very minor silt. The gravel content increases with depth, reaching 80 to 100% near the bottom of the boreholes. In boreholes C3826 and C3827, the lowermost gravel encountered was an open-framework, medium to coarse pebble (with some cobble) gravel. The open-framework texture was recognized by the field geologist and reflected during drilling, when air used to expel the drill cuttings from the borehole quickly dissipated into the formation.

This lower gravel sequence is equivalent to unit H3 of Lindsey et al. (1994), mapping unit Qfg₁, Missoula Outburst flood gravel deposits, of Reidel and Fecht (1994a, b), and the gravel-dominated facies association (GD) of the Hanford formation of DOE (2002).

3.2.2 Sand Sequence

Most of the Hanford formation encountered in the boreholes consists dominantly of fine- to coarse-grained sand with traces of silt and fine gravel (S2 and S3 in Table 5) (Figure 9). Within this sequence is a zone (G3) of gravelly sand and sandy gravel between depths of approximately 230 and 260 ft bgs in boreholes C3828 and C3926; this zone is thinner in boreholes C3826 and C3827. In boreholes C3827 and C3926, the sand sequence in these boreholes is topped by gravelly sand (G1) up to 2 ft thick.

This sand sequence is equivalent to unit H2 of Lindsey et al. (1994) and the following mapping units of Reidel and Fecht (1994a, b): Qfs₁, Qfs₂, and Qfs₃, Missoula Outburst Flood Deposits consisting of sand, silt, and clay. This sequence is also equivalent to the sand-dominated facies association (SD), and the uppermost part of the sequence is equivalent to the interbedded sand- to silt-dominated facies association (ISSD), of the Hanford formation of DOE (2002).

The sands range in composition from about 30% basaltic and 70% felsic to 70% basaltic and 30% felsic. Generally, the more basaltic-rich sands are deeper than the felsic-rich sands. The sands are generally subrounded to subangular and moderately to well sorted. The degree of compaction varies within the sand-dominated sequence with some samples being loose, uncompacted sediment and others



Figure 8. Basal Gravel from Borehole C3826 at the ILAW Site

Table 5. Summary of the Geology and Lithology of Boreholes C3826, C3827, C3828, and C3926

Hanford Units		Borehole C3826	Borehole C3827	Borehole C3828	Borehole C3926
DOE 2002	ILAW Units				
ISSD	S1	0' to 6'	0' to 23'	0' to 9'	0' to 9'
GD	G1	Not present	23' to 29'	Not present	9' to 11'
SD	S2	6' to 216'	29' to 233'	9' to 234'	11' to 230'
GD	G3	216' to 238'	23' to 236'	234' to 262'	230' to 259'
SD	S3	238' to 274'	236' to 254'	262' to 277'	259' to 275'
GD	G4	274' to 363' (TD)	254' to 372' (TD)	277' to 383' (TD)	275' to 382.5' (TD)
Not Applicable	Paleosol horizons recognized	30'6" to 30'10" 73'to 73'4", 76'8" to 77'3"	62'6" to 62'8" and 158'1.6" to 158'5.2"	161'5.7" to 161'9.7"	

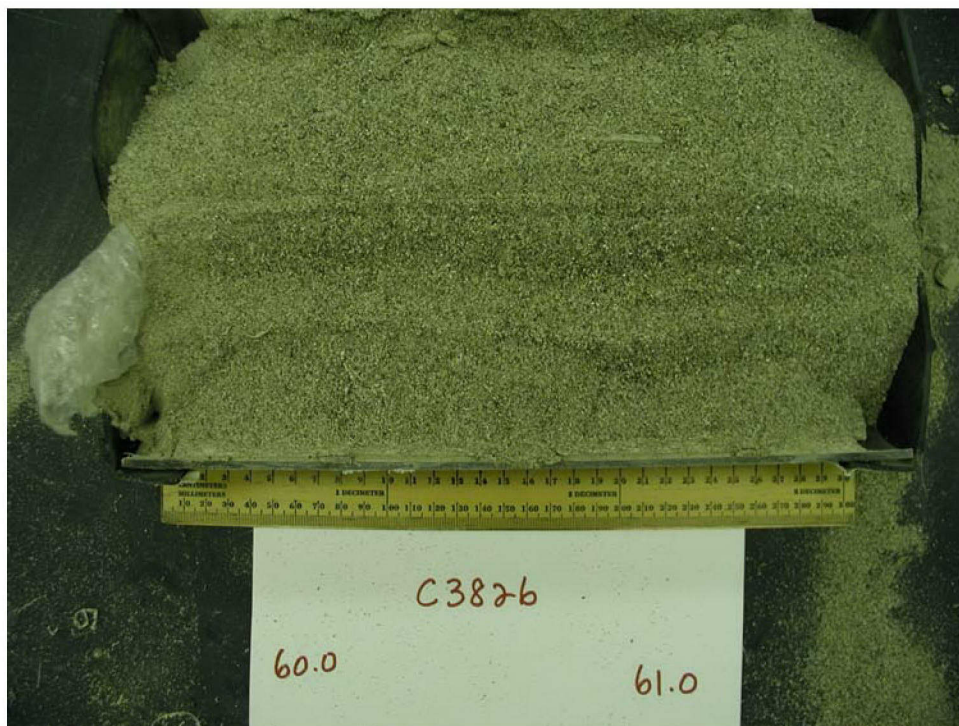


Figure 9. Sand-Dominated Unit from Borehole C3826, 60.0-61.0 Feet, at the ILAW Site

being compacted, competent sediment. The part of the sand-dominated sequence below the sandy gravel (S3) is generally more compact than the sands above the sandy gravel zone. Cementation is rare throughout the sand-dominated sequence, except at paleosols.

The dominant sedimentary feature of the sand-dominated sequence is bedding. Generally, bedding is fairly subtle and is defined by slight color changes (due to slight changes in composition) or changes in grain size. The S3 sands are generally coarser. Bedding defined by grain size changes reflects upward-fining sequences generally 2 to 4 in. (5 to 10 cm) thick.

3.2.3 Paleosols

Paleosols, or ancient soil zones, are generally calcite-cemented (caliche), bioturbated and apparently leached soil horizons where encountered. At least three paleosol horizons are identified in the drill core from these boreholes (Table 5). The first is encountered at about 30'6" bgs (Figure 10) in boreholes C3826 and C3926. A second, deeper paleosol was encountered in C3827 at a depth of about 62'6" bgs. Apparent paleosols, one of which may correlate to the deeper paleosol in C3827, were encountered at 73' bgs and 76'8" bgs in borehole C3826. A third paleosol was encountered at a depth of about 160' bgs in boreholes C3827 and 155' in C3828 (Table 5). In general, these paleosols are between 2 and 4 in. (5 to 10 cm) thick and may correlate with paleosols identified in the first and second ILAW boreholes (299-E17-21 and 299-E24-21).



Figure 10. Paleosol from Borehole C3826, Depth 30.5-31.5 Feet.
Paleosol is the light colored zone beginning at 30.5 feet.

3.2.4 Clastic Dikes

The core interval 155'6" to 157'6" from borehole C3828 contains a clastic dike (Figure 11). A cross-section cut through the core sample reveals a 3 cm-wide dike of very fine to fine sand crosscutting medium-grained sand. The dike is not observed in core samples above 155' and below 158', and its orientation and continuity is unknown.

3.3 Passive Gamma Spectral Results

Boreholes 299-E17-22, 299-E17-23, and 299-E17-25 were logged during August 2002 using a spectral gamma ray tool to verify the absence of man-made radionuclides. Previous experience from geophysical logging at 299-E17-21 and 299-E24-21 showed that the vadose zone at the ILAW site does not exhibit significant stratigraphic changes that can be detected during geophysical logging. The results of these surveys are presented in Appendix F. There are four logs: total gamma, potassium-40, uranium-238 and thorium-232. No man-made gamma-emitting contamination was detected.



Figure 11. Clastic Dike Penetrated in Borehole C3828

4.0 Groundwater Chemistry

A summary of the chemistry of groundwater samples from wells 299-E17-22, 299-E17-23, and 299-E17-25 is given in Table 6. With the exception of sulfate, all values are similar to known Site-wide background levels from DOE (1992). Measured sulfate concentrations are 84.9 and 64.1 mg/L in wells C3827 and C3926, respectively, notably higher than background. Sulfate levels in background areas range between 30.6 mg/L and 41.3 mg/L (DOE 1992). The difference between sulfate levels measured in wells C3827 and C3926 and the background levels appears to be significant.

5.0 Conclusions

Results from the FY 2002 ILAW boreholes are consistent with results from the first and second ILAW boreholes (299-E17-21, 299-E24-21, respectively). These results indicates that the ILAW site is situated above an erosional channel, that is cut into the Ringold Formation and filled with unconsolidated, open-framework gravel of the Hanford formation. Stratigraphy above the channel appears to consist of sediments representing at least three individual Lake Missoula cataclysmic flooding events.

Table 6. Groundwater Chemistry

	299-E17-22	299-E17-23	299-E17-25 ^(e)	PNL ^(a)	USGS ^(b)	WHC ^(c)
Chloride, mg/L	9.7	11.4	10.8	10.3±6.5	12.2 ± 7.8	8.8 ± 7.7
Fluoride, mg/L	0.43	0.57	0.49	0.37±0.1	0.55 ± 0.33	0.44 ± 0.13
Nitrate, mg/L	4.1	4.5	6.9	NA	3.2 ± 3.4	5.2 ± 3.6
Sulfate, mg/L	37.5	84.9	64.1	34.4±16.9	41.3 ± 27.9	30.6 ± 22.6
Tritium, pCi/L	12,600 ± 840 ^(d)	4,000 ± 430	66,900 ± 3100	NA	NA	NA
<p>(a) From PNL-6886 (Evans et al. 1989) and DOE (1992). (b) Compiled by the U.S. Geological Survey from Hanford Site area sources in the National Water Information System database; from DOE (1992). (c) Based on 7 wells located in the background area upgradient of Hanford facilities or in the southern part of the site; from DOE (1992). (d) Total uncertainty (2σ). (e) When planning for sampling, borehole C3828 (299-E17-24) was originally planned as the groundwater monitoring well and labels were prepared. When it was determined to abandon C3828 and offset drill C3926 (299-E17-25), the sampling labels were not changed but the correction was noted in the drilling activity logs.</p>						

6.0 References

Delaney, C. D., K. A. Lindsey, and S. P. Reidel. 1991. *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*. WHC-SD-ER-TI-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE. 1992. *Hanford Site Groundwater Background*. DOE/RL-93-23, U.S. Department of Energy, Richland, Washington.

DOE. 2002. *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*. DOE/RL-2002-39, U.S. Department of Energy, Richland, Washington.

Evans, J. C., R. W. Bryce, and D. R. Sherwood. 1989. *Hanford Site Groundwater Monitoring for January through June 1988*. PNL-6886, Pacific Northwest Laboratory, Richland, Washington.

Horton, D. G., S. P. Reidel, Yi-Ju Chein, and R. M. Mitchell. 2000. *Remote-Handled Low Activity Waste Disposal Facility Per-Operational Monitoring Plan*. RPP-6877, CH2M HILL Hanford Group, Richland, Washington.

Lindsey, K. A., S. P. Reidel, K. R. Fecht, J. L. Slate, A. G. Law, and A. M. Tallman. 1994. *Geohydrologic Setting of the Hanford Site, South-Central Washington*. In, D. A. Swanson and R. A. Haugerud: *Geologic Field Trips in the Pacific Northwest*, 1994 Annual Meeting, Geological Society of America, v. 1, p 1C-1-16.

Mann, F. M., R. J. Puigh, II, S. H. Finfrock, E. J. Freeman, Jr., R. Khaleel, D. H. Bacon, M. P. Bergeron, B. P. McGrail, and S. K. Wurstner. 2001. *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*. DOE/ORP-2000-24, Rev. b., U.S. Department of Energy, Office of River Protection, Richland, Washington.

Reidel, S. P., K. A. Lindsey, and K. R. Fecht. 1992. *Field Trip Guide to the Hanford Site*. WHC-MR-0391, Westinghouse Hanford Company, Richland, Washington.

Reidel, S. P., A. M. Tallman, V. G. Johnson, C. J. Chou, and S. M. Narbutovskih. 1995. *Characterization Plan for the Proposed TWRS Treatment Complex*. WHC-SD-WM-PNL-109, Westinghouse Hanford Company, Richland, Washington.

Reidel, S. P., D. G. Horton, and M. M. Valenta. 2001. *Geologic and Wireline Borehole Summary from the Second ILAW Borehole (299-E24-21)*. PNNL-13652, Pacific Northwest National Laboratory, Richland, Washington.

Reidel, S. P., K. D. Reynolds, and D. G. Horton. 1998. *Immobilized Low-Activity Waste Site Borehole 299-E17-21*. PNNL-11957, Pacific Northwest National Laboratory, Richland, Washington.

Reidel, S. P. and K. R. Fecht. 1994a. *Geologic Map of the Richland 1:100,000 Quadrangle, Washington*. Washington Division of Geology and Earth Resources Open File Report 94-8, 21p., 1 plate.

Reidel, S. P. and K. R. Fecht. 1994b. *Geologic Map of the Priest Rapids 1:100,000 Quadrangle, Washington*. Washington Division of Geology and Earth Resources Open File Report 94-13, 22p. 1 plate

Reidel, S. P. 2002. *Characterization Plan for Fiscal year 2002 Immobilized Low-Activity Waste Site Characterization Boreholes*. PNNL-13283-1, Pacific Northwest National Laboratory, Richland, Washington.

Walker, L. D. 2002. *Borehole Summary Report: 2002 Low-Activity Waste Site Well Initialization*. BHI-01647, Bechtel Hanford, Inc., Richland, Washington.

Appendix A

Well Summary Report for 2002 ILAW Well Installations

Appendix A

Well Summary Report: 2002 Immobilized Low-Activity Waste Well Installation

***Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration***

Submitted by: Bechtel Hanford, Inc.

For ERC Review

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.
Available in paper copy and microfiche.

Available for a processing fee to U.S. Department of Energy
and its contractors from:
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
(865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov
online ordering: <http://www.doe.gov/bridge>

Available for sale to the public, in paper, from:
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(800) 553-6847
fax: (703) 605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>

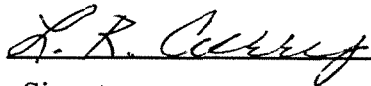
Printed in the United States of America

DISCLM-5.CHP (11/99)

APPROVAL PAGE

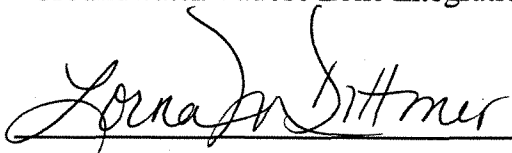
Title: Well Summary Report: 2002 Immobilized Low-Activity Waste Well Installation

Approval: L. R. Curry, Acting Project Manager/Project Engineer
Groundwater/Vadose Zone Integration Project


Signature

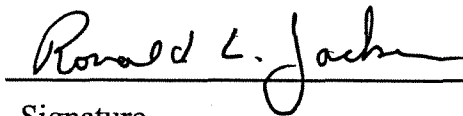
6/24/02
Date

L. M. Dittmer, Project Environmental Lead,
Groundwater/Vadose Zone Integration Project


Signature

24 June 2002
Date

R. L. Jackson, Groundwater Operations Task Lead,
Groundwater/Vadose Zone Integration Project


Signature

06/24/02
Date

The approval signatures on this page indicate that this document has been authorized for information release to the public through appropriate channels. No other forms or signatures are required to document this information release.

BHI-DIS JUR 6/24/02

Well Summary Report: 2002 Immobilized Low-Activity Waste Well Installation

Authors

L. D. Walker
C. S. Wright
CH2M HILL Hanford, Inc.

Date Published

June 2002

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	PURPOSE AND SCOPE	1
2.0	TECHNICAL DATA	3
2.1	WELL C3826/299-E17-22	3
2.1.1	Drilling Summary	3
2.1.2	Well Completion	3
2.1.3	Final Well Development and Pumping Test	5
2.2	WELL C3827/299-E17-23	5
2.2.1	Drilling Summary	5
2.2.2	Well Completion	5
2.2.3	Final Well Development and Pumping Test	7
2.3	WELL C3828/299-E17-24	7
2.3.1	Drilling Summary	7
2.3.2	Well Completion	8
2.4	WELL C3926/299-E17-25	8
2.4.1	Drilling Summary	8
2.4.2	Well Completion	9
2.5	WASTE MANAGEMENT	9
2.5.1	Vadose Zone Cuttings	10
2.5.2	Saturated Zone Cuttings	10
2.5.3	Purgewater	11
2.6	WELL ACCEPTANCE	11
2.7	CIVIL SURVEY	11
3.0	SUBSURFACE DESCRIPTION	12
3.1	200 EAST AREA GEOLOGY	12
3.1.1	Well C3826/299-E17-22 Borehole Geology	12
3.1.2	Well C3827/299-E17-23 Borehole Geology	12
3.1.3	Well C3828/299-E17-24 Borehole Geology	13

3.1.4 Well C3926/299-E17-25 Borehole Geology..... 13

3.2 HYDROGEOLOGY 14

4.0 REFERENCES 14

APPENDICES

A WELL SUMMARY SHEETSA-i

B BOREHOLE LOG SHEETS..... B-i

C WELL DEVELOPMENT AND TESTING DATA..... C-i

D SURVEY DATA REPORT SHEETS.....D-i

FIGURE

1. Well Location Map.....2

TABLES

1. Split-Spoon Sample Intervals.....4

2. Well Completion Summary.....6

3. Well Development Data.6

4. Waste Designation Sample Results, Well C3826 (299-E17-22)..... 10

5. Summary of Well Drilling and Survey Data. 11

6. Drilling Information. 12

7. Pumping Information. 14

ACRONYMS

bgs	below ground surface
DQO	data quality objective
FY	fiscal year
ID	inside diameter
ILAW	immobilized low-activity waste
OD	outside diameter
PNNL	Pacific Northwest National Laboratory
TD	total depth
UCL	upper confidence limit
WAC	<i>Washington Administrative Code</i>

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
Length			Length		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			Area		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
Acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			Mass (weight)		
Ounces	28.35	grams	grams	0.035	ounces
Pounds	0.454	kilograms	kilograms	2.205	pounds
Ton	0.907	metric ton	metric ton	1.102	ton
Volume			Volume		
Teaspoons	5	milliliters	milliliters	0.033	fluid ounces
Tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
Cups	0.24	liters	liters	0.264	gallons
Pints	0.47	liters	cubic meters	35.315	cubic feet
Quarts	0.95	liters	cubic meters	1.308	cubic yards
Gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			Radioactivity		
Picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

1.0 INTRODUCTION

This document describes the fiscal year (FY) 2002 field activities associated with drilling three characterization boreholes (299-E17-22, 299-E17-23, and 299-E17-24) at the Immobilized Low-Activity Waste (ILAW) disposal site in the 200 East Area of the Hanford Site. A fourth borehole was drilled (299-E17-25) after technical problems forced borehole 299-E17-24 to be decommissioned. The data obtained from these boreholes will support current and future ILAW disposal site performance assessments. Well locations are shown in Figure 1.

1.1 PURPOSE AND SCOPE

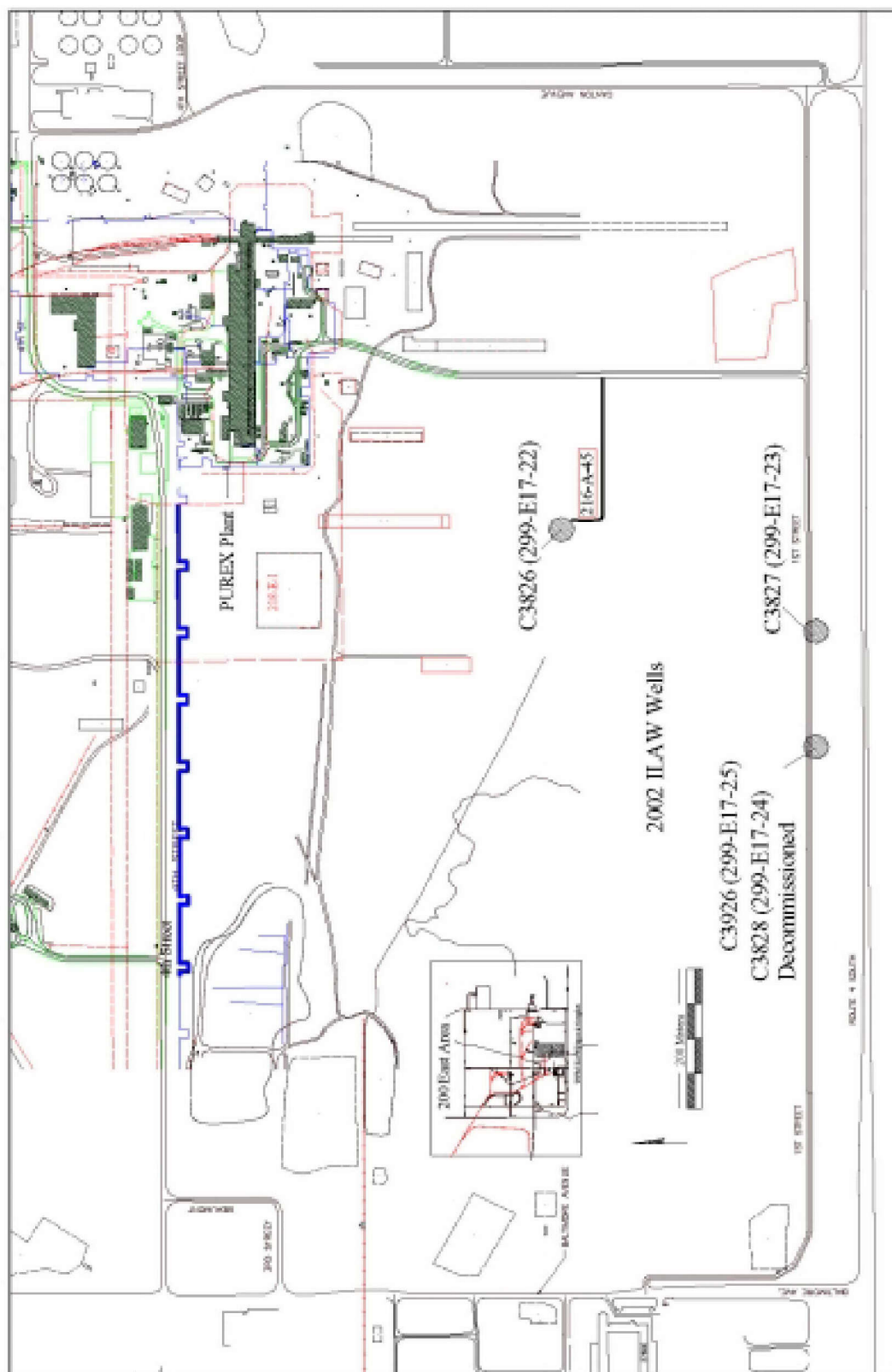
The three wells were drilled to support characterization of the physical properties of the soil at the ILAW disposal site and eventually the disposal of waste from the Hanford Site underground storage tanks. After waste is retrieved from the Hanford Site underground storage tanks, waste will be separated into two streams: (1) a low-volume, high-activity waste stream; and (2) a high-volume, low-activity waste stream. Both streams will be immobilized using the vitrification process. The immobilized high-level waste will be stored at the Hanford Site prior to shipment to a deep geological repository. The ILAW will be disposed at the Hanford Site, southwest of the Plutonium-Uranium Extraction Facility in the 200 East Area. The first ILAW disposal site characterization borehole (299-E17-21) was drilled in April 1998. The second borehole (299-E24-21) was drilled in March and April 2001.

The objective of the vadose and saturated zone characterization is to provide data to develop a geohydrologic conceptual model of the ILAW disposal site for use in the Hanford Site ILAW performance assessment (Reidel 2000). The conceptual model will be used in the performance assessment to model the movement of moisture and contaminants through the vadose zone. The characteristics of the saturated zones, as well as the results of in situ testing, will be used in groundwater modeling. After drilling, the boreholes were completed as a *Resource Conservation and Recovery Act of 1976*-compliant groundwater monitoring wells.

Descriptions of drilling, geologic conditions and materials, well construction, and well development for both wells are presented in Section 2.0. Section 3.0 provides a brief description of subsurface conditions based on geologic and hydrogeologic data collected during the installation of the wells. References are listed in Section 4.0. Well summary sheets and geologic borehole logs are included in Appendices A and B, respectively. Well development data are presented in Appendix C. Survey data report sheets are included in Appendix D.

All drilling activities were documented in accordance with BHI-EE-02, *Environmental Requirements*, Procedure 14.0, "Drilling, Maintaining, Remediating, and Decommissioning Resource Protection Wells, GeoProbe and Geotechnical Soil Borings." A geologic log was prepared for each well in accordance with BHI-EE-01, *Environmental Investigations Procedures*, Procedure 7.0, "Geologic Logging." The drilling data in this report are presented in the English units in which they were measured.

Figure 1. Well Location Map.



2.0 TECHNICAL DATA

2.1 WELL C3826/299-E17-22

This section contains a summary and description of drilling, well completion, and well development activities performed during the installation of well C3826/299-E17-22.

2.1.1 Drilling Summary

Drilling of well C3826/299-E17-22 was performed in accordance with the *Characterization Plan for Fiscal Year 2002 Immobilized Low-Activity Waste Site Characterization Boreholes* (Reidel 2002). Well summary information for this well is presented in Appendix A.

Drilling of well C3826/299-E17-22 using the dual-wall percussion method (Becker hammer drill[®]) began on March 29, 2002, advancing outer 9-in. outside diameter (OD) and inner 6-in. inside diameter (ID) temporary casing. Groundwater was encountered at approximately 322 ft below ground surface (bgs) on April 9, 2002. Waste designation samples were collected at 70 and 170 ft bgs, as described in Section 2.5. Archive samples (in volumes of 1 pint each) were collected at 5-ft intervals, and 23 split-spoon samples were collected from the intervals shown in Table 1. Split-spoon samplers consisted of two 2-ft (4 ft total) sample bodies coupled together in series with a 0.5-ft drive shoe. The split spoons were 5 in. OD and contained four 1-ft Lexan[®] liners (4 in. in diameter). Each sampler was driven on a 3.5-in.-diameter drill rod by the surface diesel hammer. The borehole was advanced to a total depth (TD) of 363 ft bgs (temporary casing 362.5 ft bgs) on April 11, 2002.

2.1.2 Well Completion

Well construction materials, filter-pack installation and initial well development, and the annular seal for well C3826 are discussed in the following subsections. A summary of well completion is provided in Table 2 and in the well summary sheets presented in Appendix A.

2.1.2.1 Screen, Riser Casing, and Filter Pack. A 35-ft-long 20-slot (0.020-in.) continuous v-wire wrap stainless-steel screen (with a 2-ft sump) and 10-20 mesh (0.0787- to 0.0331-in.) filter-pack sand were preselected for this well based on data from nearby wells and anticipated formation characteristics. The bottom of the sump was placed at 358.66 ft bgs, and the bottom of the screen was placed at 356.66 ft bgs. The top of the screen was located at 321.63 ft bgs. The borehole was backfilled with 10-20 mesh filter-pack sand from TD to 15 ft above the top of the screen (306.3 ft bgs).

[®] Becker hammer is a registered trademark of Foremost Industries, Calgary, Canada.

[®] Lexan is a registered trademark of General Electric Company, USA.

Table 1. Split-Spoon Sample Intervals.

Well C3826	Well C3827	Well C3828
8-51 (10 samples)		
	53.5-57.5	53.5-57.5
58-62	58-62	58-62
63.5-67.5	62.5-66.5	62.5-66.5
68-72		
72.5-76		
76.5-80.5	76-80	
96-100	98-102	
119-123	119-123	
149-153	149-153	
	153.5-157.5	153.5-157.5
	158-162	158-162
163.5-167.5	162.5-166.5	162.5-166.5
168-172		
172.5-176.5		
179-183	179-183	
219-223	219-223	

Note: Depths are in feet below ground surface.

2.1.2.2 Filter-Pack Installation and Initial Well Development. When installing the filter-pack material the objectives are to introduce the silica sand into the annular space around the screen, settle the filter pack to eliminate void spaces, and begin removal of fines and recondition the borehole walls from the effects of drilling. A dual-flange surge block was used to develop and settle the filter-pack material opposite the screen. The surge block was typically operated for 20 minutes per 2- to 3-ft stroke interval. Care was taken to maintain overlap between the filter sand and temporary casing so that formation material would not cave in against the well screen. The level of the filter pack was measured periodically with a weighted steel tape to monitor progress and ensure the integrity of the completion. The bottom of the well was also checked for fill material to determine if any fine material was accumulating in the screen during surging. This material was removed, as needed.

2.1.2.3 Annular Seal. Approximately 9 ft (297.0 to 306.3 ft bgs) of annular seal was constructed above the filter pack using 0.25-in. bentonite pellets, and a granular bentonite seal placed to 9.4 ft bgs. A grout seal was placed from the bentonite seal to ground surface. The grout seal consisted of Portland cement mixed with no more than 5% bentonite by weight, in accordance with *Washington Administrative Code* (WAC) 173-160.

2.1.3 Final Well Development and Pumping Test

Final well development was performed on May 21, 2002, after the surface cement pad and protective casing were installed. A 3-HP electric submersible pump (Grundfos[®] type 16S30-24) was used to pump at two depth intervals until the turbidity was less than 5 nephelometric turbidity units (NTU) and other water parameters had stabilized (i.e., temperature, conductivity, pH). First, the pump was operated with the intake 5 ft above the bottom of the well screen. At this depth the pump could only produce 11 gal/min. Drawdown of the water level during pumping was monitored by a pressure transducer and recorded in a datalogger. Water samples (C3828_1, C3828_2, and C3828_3) were collected at this depth for analyses by Pacific Northwest National Laboratory (PNNL). The pump intake was then raised to 22 ft above the bottom of the screen, and pumping resumed until the turbidity was again below 5 NTU. Final groundwater parameters are presented in Table 3.

2.2 WELL C3827/299-E17-23

This section contains a summary and description of drilling, well completion, and well development activities performed during the installation of well C3927/199-E17-23.

2.2.1 Drilling Summary

Drilling of well C3827/299-E17-23 was performed in accordance with the characterization plan for FY 2002 (Reidel 2002). Well summary information for this well is presented in Appendix A.

Drilling of well C3827/299-E17-23, using the dual-wall percussion method (Becker hammer drill) began on April 17, 2002, advancing outer 9-in. OD and inner 6-in. ID temporary casing. Groundwater was encountered at approximately 332.5 ft bgs on April 25, 2002. Archive samples were collected at 5-ft intervals, and 12 split-spoon samples were collected from the intervals shown in Table 1. The split-spoon samplers for this borehole retrieved 4 ft of sediment in four 1-ft-length Lexan liners. The borehole was advanced to a TD of 372 ft bgs (temporary casing 372 ft bgs) on April 25, 2002.

2.2.2 Well Completion

Well construction materials, filter-pack installation and initial well development, and the annular seal for well C3827 are discussed in the following subsections. A summary of well completion is provided in Table 2 and in the well summary sheets presented in Appendix A.

[®] Grundfos is a registered trademark of Grundfos Pumps Corporation, Clovis, California.

Table 2. Well Completion Summary.

Well Name	Well ID	Water Level (ft bgs)	Screen					Sandpack	Bentonite Pellets	Granular Bentonite Seal	Grout
			Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	Sump (ft)	Screen Material	Interval (ft bgs)	Interval (ft bgs)	Interval (ft bgs)	Interval (ft bgs)
299-E17-22	C3826	321.82	321.63	356.66	35	2	304L SS	306.3-362.7	297.0-306.3	9.4-297.0	0-9.4
299-E17-23	C3827	332.5	332.98	368.10	35	2	304L SS	323.0-370.5	316.1-323.0	316.1-9.9	0-9.9
299-E17-24	C3828	341.3	NA	NA	NA	NA	NA	330-383	NA	330-9.5	0-9.5
299-E17-25	C3926	337.67	336.56	371.57	35	2	304L SS	326.8-382.5	316-326.8	316-10.8	0-10.8

NA = not applicable

SS = stainless steel

Table 3. Well Development Data.

Well Name	Well ID	Static Water Level (ft bgs)	Development Date	Duration (minutes)	Final Turbidity (NTU)	Final Conductivity (μS/cm)	Final pH (standard units)	Final Temp. (°C)	Final Flow Rate (gal/min)	Final Drawdown (ft)	Total Gallons Pumped
299-E17-22	C3826	321.82	5/21/02	99	2.66	454	7.96	19.6	13	0	1,150
299-E17-23	C3827	332.51	5/20/02	75	4.34	513	7.79	21.4	11	0	870
299-E17-24	C3828	341.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
299-E17-25	C3926	337.62	5/20/02	88	4.32	428	7.77	20.1	12	0	1,020

NA = not applicable

2.2.2.1 Screen, Riser Casing, and Filter Pack. A 35-ft-long 20-slot (0.020-in.) continuous v-wire wrap stainless-steel screen (with a 2-ft sump) and 10-20 mesh (0.0787- to 0.0331-in.) filter-pack sand were preselected for this well based on data from nearby wells and anticipated formation characteristics. The bottom of the sump was placed at 370.11 ft bgs, and the bottom of the screen placed at 368.10 ft bgs. The top of the screen was located at 332.98 bgs. The borehole was backfilled with 10-20 mesh filter-pack sand from TD to 10 ft above the top of the screen (323 ft bgs). Filter-pack installation at injection well C3827 followed the same procedure as previously described for extraction well C3826 (see Section 2.1.2.2).

2.2.2.2 Annular Seal. Approximately 7 ft (316.1 to 323.0 ft bgs) of annular seal was constructed above the filter pack using 0.25-in. bentonite pellets and a granular bentonite seal placed to 9.9 ft bgs. A grout seal was placed from the bentonite seal to ground surface. The grout seal consisted of Portland cement mixed with no more than 5% bentonite by weight, in accordance with WAC 173-160.

2.2.3 Final Well Development and Pumping Test

Final well development was performed on May 20, 2002, after the surface cement pad and protective casing had been installed. A 3-HP electric submersible pump was used at two depths to develop the well. First, the pump intake was set 2 ft above the bottom of the screen, and pumping continued until the turbidity was less than 5 NTU. A pressure transducer was used to monitor water-level drawdown during pumping, and information was recorded in a datalogger. Other parameters monitored during pumping were temperature, conductivity, and pH. At this depth, water samples (C3827_1, C3827_2, and C3827_3) were collected for PNNL analyses. The pump intake was raised to 16 ft above the bottom of the screen, and pumping resumed until the turbidity was less than 5 NTU. The pumping rate was 12 gal/min. Final groundwater parameters are presented in Table 3. No significant water-level drawdown was noted at either depth.

2.3 WELL C3828/299-E17-24

This section contains a summary and description of drilling and well decommissioning activities performed during the attempted installation of well C3828/299-E17-24.

2.3.1 Drilling Summary

Drilling of well C3828/299-E17-24 was performed in accordance with the characterization plan for FY 2002 (Reidel 2002). Well summary information for this well is presented in Appendix A.

Drilling of well C3828/299-E17-24 using the dual-wall percussion method (Becker hammer drill) began on May 2, 2002, advancing outer 9-in. OD and inner 6-in. ID in temporary casing. Groundwater was encountered at approximately 340 ft bgs on April 9, 2002. Six split-spoon samples were collected from the intervals shown in Table 1. The split-spoon samplers for this borehole retrieved 4 ft of sediment in two 2-ft-length Lexan liners. The borehole was advanced to a TD of 383 ft bgs (temporary casing 383 ft bgs) on May 6, 2002.

2.3.2 Well Completion

Borehole C3828 was drilled to 383 ft bgs and passed the straightness test prior to installation of the well screen. When the well construction was started, the drilling subcontractor was unable to get a measuring tape to the bottom of the well in the annular space between the 4-in. stainless-steel permanent casing and the inner 6-in. temporary casing. This measurement is critical to ensure the proper placement of the silica sand pack around the well screen. The well was observed to veer to the east at approximately 85 ft bgs. During drilling a rock was hit at 280 ft, which may also have deflected the drill bit. After a discussion with CH2M Hill Hanford Group, Inc. and project management, it was agreed to decommission well C3828, move the drilling rig, and drill a new borehole.

A summary of well decommissioning is provided in Table 2 and in the well summary sheets presented in Appendix A. A well decommissioning profile for well C3828 (299-E17-24) was generated by the Groundwater/Vadose Zone Integration Project single point of contact prior to the actual well decommissioning.

2.3.2.1 Well Decommissioning. During backpulling of the temporary casing from well C3828 (299-E17-24), silica sand was emplaced from 383 ft bgs to approximately 330 ft bgs, granular bentonite (crumbles) placed from 330 ft bgs to 9.5 ft bgs, and a concrete seal was placed from the bentonite seal to ground surface. A brass marker was placed in the surface of the concrete seal. Decommissioning was completed on May 10, 2002.

2.4 WELL C3926/299-E17-25

This section contains a summary and description of drilling, well completion, and well development activities performed during the installation of well C3926/299-E17-25.

2.4.1 Drilling Summary

Drilling of extraction well C3926/299-E17-25 was performed as a redrill of well C3828. The borehole location was set approximately 10 ft due west of the C3828 site. The well was drilled in accordance with the characterization plan for FY 2002 (Reidel 2002). Well summary information for this well is presented in Appendix A.

Drilling of well C3926/299-E17-25 using the dual-wall percussion method (Becker hammer drill) began on May 10, 2002, advancing outer 9-in. OD and inner 6-in. ID in temporary casing. Groundwater was encountered at approximately 338 ft bgs on May 13, 2002. Archive grab samples were collected at 10-ft intervals. No split-spoon samples were collected. The borehole was advanced to a TD of 382.5 ft bgs on May 13, 2002.

2.4.2 Well Completion

Well construction materials, filter-pack installation and initial well development, and annular seal for well C3826 are discussed in the following subsections. A summary of well completion is provided in Table 2 and in the well summary sheets presented in Appendix A.

2.4.2.1 Screen, Riser Casing, and Filter Pack. A 35-ft 20-slot (0.020-in.) continuous v-wire wrap stainless-steel screen (with a 2-ft sump) and 10-20 mesh (0.0787- to 0.0331-in.) filter-pack sand were preselected for this well based on data from nearby wells and anticipated formation characteristics. The bottom of the sump was placed at 373.58 ft bgs and the bottom of the screen placed at 371.57 ft bgs. The top of the screen was located at 336.56 ft bgs. The borehole was backfilled with 10-20 mesh filter-pack sand from TD to 10 ft above the top of the screen (326.8 ft bgs). Filter-pack installation at well C3827 followed the same procedure as previously described for well C3826 (see Section 2.1.2.2).

2.4.2.2 Annular Seal. Approximately 10 ft (326.8 to 316 ft bgs) of annular seal was constructed above the filter pack using 0.38-in. bentonite pellets and a granular bentonite seal placed to 9.4 ft bgs. A grout seal was placed from the bentonite seal to ground surface. The grout seal consisted of Portland cement mixed with no more than 5% bentonite by weight, in accordance with WAC 173-160.

2.4.2.3 Final Well Development and Pumping Test. Final well development was performed on May 20, 2002, after the surface pad and protective casing had been set. A 3-HP electric submersible pump was first set near the bottom of the screen interval, with the pump intake at 6 ft above the bottom of the screen. From that depth, the pump could only produce 11 gal/min. A pressure transducer was used to monitor water-level drawdown during pumping, and information was stored in a HermitTM 3000 datalogger. Pumping continued until the turbidity was measured to be less than 5 NTU. Other water quality parameters measured during pumping were temperature, conductivity, and pH. Water samples (C3826_1, C3826_2 and C3826_3) were collected for PNNL analyses. The pump intake was then raised to 20 ft above the bottom of the screen, and pumping resumed until the turbidity was less than 5 NTU. The pumping rate was about 12 gal/min. Final groundwater-quality parameters are presented in Table 3. No significant drawdown of the water table was noted at either pumping depth.

2.5 WASTE MANAGEMENT

Waste for all boreholes was managed in accordance with the *Data Quality Objective Summary Report for ILAW Well Installation - Waste Disposition* (BHI 2002) and the *Site Specific Waste Management Instruction Well Decommissioning, Maintenance and Sampling* (Stocker 2000).

TM Hermit is a trademark of In-Situ Inc., Laramie, Wyoming.

2.5.1 Vadose Zone Cuttings

As discussed in the data quality objective (DQO) summary report (BHI 2002), waste designation samples were collected from ILAW borehole C3826 (299-E17-22) at two locations (70 and 170 ft bgs). Soil samples B149P3 (70 ft) and B149P5 (170 ft) were analyzed for selected radionuclides and nitrate per the DQO summary report (BHI 2002).

Initial radiological screening (for sample shipping purposes) showed nondetects for gamma emitters and 18 pCi/g for gross beta. While gross beta was not discussed as a contaminant of concern in the DQO summary report (BHI 2002), after a discussion with the Bechtel Hanford, Inc. waste management task lead, it was determined that it was appropriate to compare the screening data with the 90% upper confidence limit (UCL) background value for gross beta. The published background value is 22.96 pCi/g (DOE-RL 1996). As shown in Table 4, laboratory sample values were compared to the 90% UCL as requested by the DQO, for site background data. All reported values are less than background.

Table 4. Waste Designation Sample Results, Well C3826 (299-E17-22).

Constituent	90% UCL Background	Sample B149P3 (70 ft)	Sample B149P5 (170 ft)
Cesium-137	0.0919 pCi/g	Nondetect	Nondetect
Strontium-90	0.167 pCi/g	-0.014 pCi/g	-0.149 pCi/g
Uranium-234	1.1 pCi/g	0.336 pCi/g	0.611 pCi/g
Uranium-235	0.109 pCi/g	0.057 pCi/g	0.085 pCi/g
Uranium-238	1.06 pCi/g	0.46 pCi/g	0.423 pCi/g
Plutonium-238	0.0047 pCi/g	0.003 pCi/g	-0.008 pCi/g
Plutonium-239/240	0.0192 pCi/g	-0.003 pCi/g	0.008 pCi/g
Nitrate	99.38 mg/kg	2.79 mg/kg	2.29 mg/kg

Waste from boreholes C3827 (299-E17-23), C3828 (299-E17-24), and C3926 (299-E27-25) did not require waste designation sampling. The drilling area and drill cuttings were monitored regularly for radioactive contaminants; no contaminants were detected above background levels. Drilling spoils from above the water table were accumulated in piles near the point of generation until surveyed by a radiological control technician. Spoils piles were approved for return to ground following clearance from the radiological control technician, the project task lead, and the waste management task lead.

2.5.2 Saturated Zone Cuttings

Drill cuttings removed below the water table in all four boreholes were contained in waste storage drums for final disposition.

2.5.3 Purgewater

All groundwater pumped from these wells during development activities was contained and transferred to purgewater trucks for final disposal at the Purgewater Storage and Treatment Facility and/or ModuTanks,TM in accordance with the DQO summary report (BHI 2002).

2.6 WELL ACCEPTANCE

A well acceptance walkdown for the three completed wells was performed on May 21, 2002 (see Table 5 for a summary).

Table 5. Summary of Well Drilling and Survey Data.

Well Name	Well ID	Drilling Start Date	Drilling Finish Date	Northing ^a (Brass Cap) (m)	Easting ^a (Brass Cap) (m)	Ground-Surface Elevation ^b (Brass Cap) (m)	Total Depth (ft bgs)
299-E17-22	C3826	3/27/02	4/11/02	135195.921	574841.067	220.589	363
299-E17-23	C3827	4/16/02	4/26/02	134842.766	574694.485	223.843	372
299-E17-24	C3828	5/1/02	5/06/02	134845.545	574518.125	224.801	383
299-E17-25	C3926	5/10/02	5/13/02	134845.913	574515.171	225.028	382.5

NOTE: Feet are used because field measurements were reported and recorded in English units.

^a Northing and easting coordinates are based on Washington State Plane Coordinates (North American Datum of 1983[91]).

^b North American Vertical Datum of 1988 values rounded to 0.001 m.

2.7 CIVIL SURVEY

Well location and elevation surveys were performed on the wells in May 2002 by Rogers Surveying, Inc. The coordinates for the wells were determined using Trimble 4000ssiTM dual-frequency global positioning system receivers, operating in real-time kinematic mode. The horizontal control for this survey is based on a global positioning system control network designed and surveyed by Rogers Surveying, Inc., in support of the Hanford Site Mapping Project.

Elevations were determined using a Leica Geosystems N3003 electronic bar code reading level and bar code rod. The vertical control for these wells perpetuated from horizontal control monument HSWB044. All coordinates are referenced to the Washington Coordinate System, North American Datum of 1983/1991. Elevations are referenced to the North American Vertical Datum of 1988. All results are reported in metric units with a vertical accuracy of +/-0.001 m

TM ModuTank is a trademark of ModuTank Inc., Long Island City, New York.

TM Trimble 4000ssi is a trademark of Trimble Navigation Limited

and horizontal accuracy of +/-0.001 m. Surveying was performed in accordance with the requirements of BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques."

3.0 SUBSURFACE DESCRIPTION

3.1 200 EAST AREA GEOLOGY

The stratigraphy of the ILAW disposal site consists of the Hanford formation and the Ringold Formation overlying the Columbia River Basalt Group (Reidel 2000). Surficial sediments are mainly eolian deposits consisting of reworked Hanford Site sands and silts.

3.1.1 Well C3826/299-E17-22 Borehole Geology

The first 6 ft consisted of fine sand and silt, and the sand-dominated sequence of the Hanford formation continued until 216 ft bgs. The sand was moist to about 6 ft, and then dry below that depth until near the top of groundwater. Trace amounts of caliche fragments were noted on the borehole log. The sediment was predominantly gravelly sand from 216 to 238 ft, sand from 238 to 274 ft, gravelly sand from 274 to 293 ft, basal-gravel (Hanford formation) from 293 to 352 ft, and sandy gravel (Ringold Formation) from 352 to 363 ft (TD).

Geologic borehole logs are included in Appendix B and stratigraphic information summarized in Table 6.

Table 6. Drilling Information.

Well Name	Well ID	Ground Surface Elevation ^a (Estimated) (m)	Top of Hanford Gravel Sequence (ft bgs)	Hanford/Ringold Contact (ft bgs)	Groundwater Depth ^b (ft bgs)	Total Depth (ft bgs)
299-E17-22	C3826	220.494	293	352	321.8	363
299-E17-23	C3827	223.370	272	Indistinct	332.5	372
299-E17-24	C3828	224.625	277	Indistinct	341.3 ^b	383
299-E17-25	C3926	224.625	275	Indistinct	337.6	382.5

^a North American Vertical Datum of 1988.

^b Water level could be inaccurate due to off-vertical drill casing.

3.1.2 Well C3827/299-E17-23 Borehole Geology

At this location the surface deposit of silty sand extended to about 8 ft bgs, followed by basalt-rich sand from 8 to 23 ft. Gravelly sand with fine pebbles continued from 23 to 29 ft, and then Hanford sand from 29 to 233 ft. This sand was slightly moist until about 130 ft and then dry

below that depth. A gradational change to sandy gravel occurred from 233 to 236 ft, and then sand again to 254 ft. From 254 to 272 ft, the sediment alternated from gravelly sand to sandy gravel with fine- to medium-sized gravel pebbles. At 272 ft, the basal-gravel-dominated Hanford formation was encountered. There was not a clear contact noted between Hanford and Ringold gravel formations, but there was a possible contact at about 358 ft as sandy gravel continued until the total drill depth of 372 ft bgs.

Geologic borehole logs are included in Appendix B, and stratigraphic information is summarized in Table 6.

3.1.3 Well C3828/299-E17-24 Borehole Geology

Sediment from the surface to 33 ft bgs consisted of sand, with trace amounts of silt and fine gravel. Sand continued from 33 to 234 ft. The sand contained occasional fragments of silt and clay, which were moist and reacted strongly with 10% hydrochloric acid. A possible paleosol was noted in a split-spoon sample at 157 ft. The sand was slightly moist until about 220 ft, and dry below that depth. Gravelly sand with fine pebbles was encountered from 234 to 237 ft, and then sand to 244 ft. Sandy gravel, again mostly fine to very fine pebbles, extended from 244 to 262 ft, then sand to 277 ft. An abrupt contact with sandy gravel at 277 ft was the basal Hanford gravel sequence. The gravel was occasionally cobble to boulder in size, with several intervals with silt coatings on gravel. There was no clear contact between Hanford and Ringold Formations; no open-framework gravel was encountered at this borehole. A large basalt boulder was drilled through at 367 to 369 ft, and basalt-rich gravel extended to the total depth of 383 ft.

Geologic borehole logs are included in Appendix B, and stratigraphic information is summarized in Table 6.

3.1.4 Well C3926/299-E17-25 Borehole Geology

From the surface to 36 ft bgs, the sediment graded from slightly silty sand to gravelly sand and sand from 36 to 230 ft. This borehole also showed traces of silt, clay, and caliche fragments, but not to the extent seen in well C3828. The sand was slightly moist until about 220 ft and dry below that depth. Gravelly sand was seen from 230 to 235 ft, and then sand to 240 ft. Gravelly sand to sandy gravel was encountered from 240 to 259 ft, and then sand to 275 ft. The basal Hanford gravel sequence started at 275 ft, with gravel up to cobble and boulder size. There was no clear contact between Hanford and Ringold gravel, as sandy gravel continued to the total drill depth of 382.5 ft. At a depth interval of approximately 368 to 378 ft, the silt fraction in the gravel was a very dark brown (almost black) then back to a light brown, as seen earlier in this borehole and in other boreholes below the water table.

Geologic borehole logs are included in Appendix B, and stratigraphic information is summarized in Table 6.

3.2 HYDROGEOLOGY

The uppermost aquifer in the vicinity of the ILAW disposal site is within the fluvial gravels of the Ringold Formation and flood deposits of the Hanford formation. The Elephant Mountain Member of the Columbia River Basalt Group forms the base of the unconfined aquifer. Drawdown information from well development pumping is shown in Table 7. No other aquifer testing was performed.

Table 7. Pumping Information.

Well Name	Well ID	Groundwater Level (ft bgs)	Final Flow Rate (gal/min)	Drawdown ^b (ft)	Pumping Duration (minutes)	Recovery (minutes)
299-E27-22	C3826	321.8	13	0	99	0
299-E17-23	C3827	332.5	11	0	75	0
299-E17-24	C3828	341.3 ^a	NA	NA	NA	NA
299-E17-25	C3926	337.6	12	0	88	0

^a Water level could be inaccurate due to off-vertical drill casing.

^b Pump was of insufficient size to generate a drawdown at these depths.

NA = not applicable

4.0 REFERENCES

- BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.
- BHI-EE-02, *Environmental Requirements*, Bechtel Hanford, Inc., Richland, Washington.
- BHI, 2002, *Data Quality Objective Summary Report for ILAW Well Installation – Waste Disposition*, BHI-01603, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
- DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- Reidel, S. P., 2000, *Second ILAW Site Borehole Characterization Plan*, PNNL-13283, Pacific Northwest National Laboratory, Richland, Washington.
- Reidel, S. P., 2002, *Characterization Plan for Fiscal Year 2002 Immobilized Low-Activity Waste Site Characterization Boreholes*, PNNL-13283-1, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

Stocker, D. E., 2000, *Site Specific Waste Management Instruction Well Decommissioning, Maintenance and Sampling*, WMI-WELL001, Rev. 5, Bechtel Hanford, Inc., Richland, Washington.

WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” *Washington Administrative Code*, as amended.

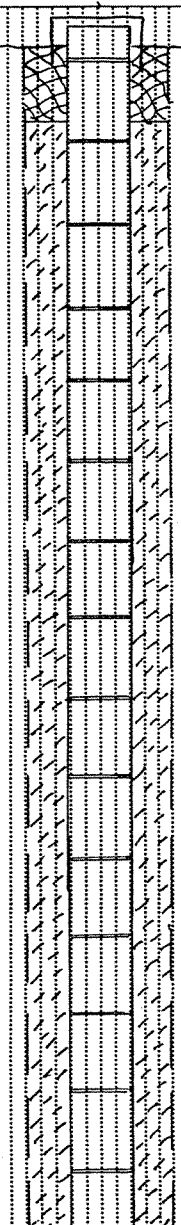
APPENDIX A

WELL SUMMARY SHEETS

Appendix A - Well Summary Sheets

BHI-01647

Rev. 0

WELL SUMMARY SHEET		Start Date: 3-29-02	Page: 1 of 3
		Finish Date: 4-16-02	
Well ID: C 3826	Well Name: 299-E/7-22		
Location: SW of Purex, 200-East		Project: CY 2002 ILAW Drilling	
Prepared By: L.D. Walker	Date: 4-16-02	Reviewed By: C.D. Walker	Date: 7/10/02
Signature: <i>[Signature]</i>		Signature: <i>[Signature]</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
6" protective casing set 1.0' above 4" well casing		0	0' → 0.5': Gravel drill pad
Portland Cement Grout: 0' → 9.4'			0.5' → 6': Silty SAND
Temporary drill casing: 9 5/8" by 6" dual wall		25	6' → 216': SAND
Permanent Well Casing: 4" sch. 5 304/304L stainless steel		50	
+2.40' → 321.63'		75	
Granular Bentonite Annular Seal: 9.4' → 297.0'		100	
		125	

Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

BHI-01647



Rev. 0

WELL SUMMARY SHEET		Start Date: 3-29-02	Page: 2 of 3
		Finish Date: 4-16-02	
Well ID: C 3826	Well Name: 299- E17- 22		
Location: SW of Purex , 200 East	Project: CY 2002 ILAW Drilling		
Prepared By: L.D. Walker	Date: 4-16-02	Reviewed By: C.S. Weibert	Date: 5/10/02
Signature: <i>[Signature]</i>		Signature: <i>[Signature]</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
		150	
			224' → 231': SAND
			231' → 238': Gravelly SAND
			238' → 274': SAND
			245': tr cobble
			274' → 279': Gravelly SAND
			279' → 283': SAND
			283' → 293': Gravelly SAND
			293' → 302': Sandy GRAVEL

Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

WELL SUMMARY SHEET

WELL SUMMARY SHEET			Start Date: 3-29-02	Page: 3 of 3
Well ID: C3826	Well Name: 299-E17-22		Finish Date: 4-16-02	
Location: SW of Purex, 200 East	Project: CY 2002 ILAW Drilling			
Prepared By: L.D. Walker	Date: 4-16-02	Reviewed By: C.S. Walker	Date: 5/6/02	
Signature: 	Signature: 			

CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
1/4" Bentonite Pellets:			
297.0' → 306.3'			
Colorado Silica Sand,			
10-20 mesh:			
306.3' → 362.7'			
Well screen:			
4" 304L Stainless Steel			
Cent. wire-wrapped			
0.020-in slot			
321.63' → 356.66'			
Tailpipe / Sump:			
4" sch. 5 304/304L			
with welded endcap			
356.66' → 358.66'			
Total length of stainless			
Steel well is 361.06'			
All depths are in feet			
below ground surface			
All temporary casing			
was removed from ground			


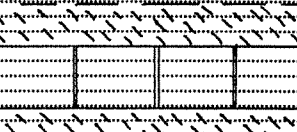
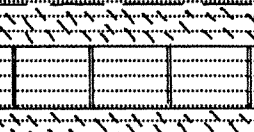
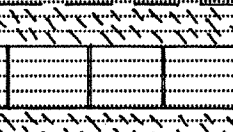
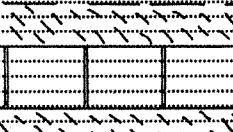
Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

BHI-01647

Rev. 0

WELL SUMMARY SHEET		Start Date: 4-17-02	Page: 1 of 3
Well ID: C3827	Well Name: 299-E17-23	Finish Date: 4-30-02	
Location: SW of Purex, on 200E Fenceline	Project: CY 2002 ILAW Drilling		
Prepared By: L.D. Walker	Reviewed By: CS Unilev	Date: 4/16/02	
Signature: <i>[Signature]</i>	Signature: <i>[Signature]</i>		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
Protective Surface Casing: 6" SS set 1.0' above the 4" well casing		0	0' → 1.5': Sandy GRAVEL drill pad
Portland Cement Grout: 0' → 9.9'		25	8' → 23': SAND 23' → 29': Gravelly SAND 29' → 233': SAND
Temporary drill casing: 9" by 6" dual wall		50	
Permanent Well Casing: 4" sch. 5 304/304L Stainless Steel +2.2' → 332.98'		75	
Granular Bentonite Annular Seal: 9.9' → 316.1'		100	
		125	

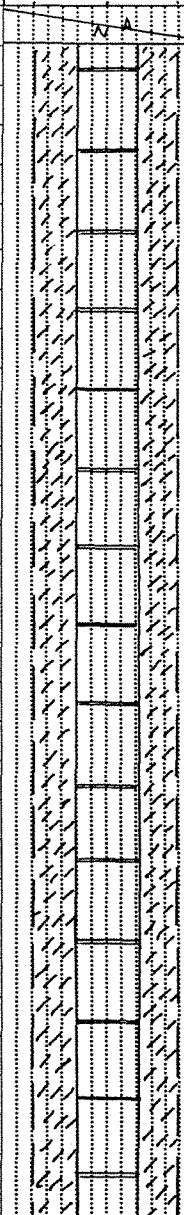
Original to: Document & Information Services, HO-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, HO-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

BHI-01647

Rev. 0

WELL SUMMARY SHEET		Start Date: 4-17-02	Page: 2 of 3
		Finish Date: 4-30-02	
Well ID: C3827	Well Name: 299-E17-23		
Location: SW of Purex on 200E Fence/line	Project: CY 2002 ILAW Drilling		
Prepared By: L.D. Walker	Date: 4-30-02	Reviewed By: Charlene Martinez	Date: 05/29/02
Signature: <i>L.D. Walker</i>		Signature: <i>Charlene Martinez</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
		150	N.A.
		175	
		200	
		225	233' → 236': Sandy GRAVEL
		250	236' → 254': SAND
		275	254' → 257': Gravelly SAND 257' → 260': SAND 260' → 264': Gravelly SAND 264' → 268': Sandy GRAVEL 268' → 272': Gravelly SAND 272' → 281': Sandy GRAVEL 281' → 284': GRAVEL 284' → 312': Sandy GRAVEL

Original to: Document & Information Services, H0-09/HWIS

Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Well Summary Report: 2002 ILAW Well Installation

June 2002

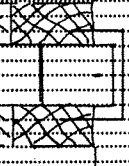

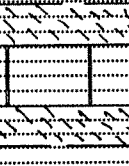

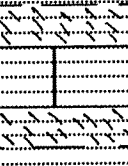

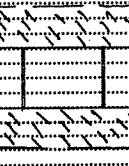
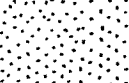
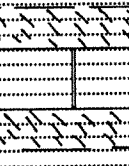
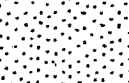
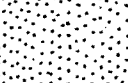
A-5

Appendix A - Well Summary Sheets

Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BH1-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

WELL SUMMARY SHEET			Start Date: 5-10-02	Page: 1 of 3
			Finish Date: 5-16-02	
Well ID: C 3926	Well Name: 299-E17-25			
Location: SW of Purex on 200E Fenceline	Project: CY 2002 ILAW Drilling			
Prepared By: L.D. Walker	Date: 5-16-02	Reviewed By: CS Winkler	Date: 5-16-02	
Signature: <i>L.D. Walker</i>	Signature: <i>CS Winkler</i>			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description
Protective Surface Casing: 6" SS set 1.0' above the 4" well casing		0		0' → 1.5': Crushed rock drill pad
Portland Cement Grout: 0' → 10.8'		25		1.5' → 9': Slightly Silty SAND
Temporary drill casing 9" by 6" dual wall		50		9' → 11': Gravelly SAND
Permanent Well Casing: 4" ID 304/304L stainless steel + 2.0' → 336.56'		75		11' → 15': SAND
Granular Bentonite Annular Seal: 10.8' → 316.0'		100		15' → 36': Slightly Silty SAND
		125		36' → 230': SAND

Original to: Document & Information Services, HO-09/HWIS

Distribution by DIS: Environmental Technologies Well Coordinator, HO-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

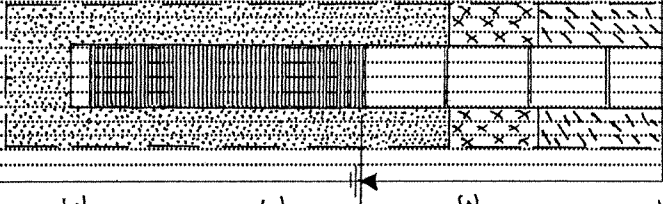

WELL SUMMARY SHEET		Start Date: 5-10-02	Page: 2 of 3
		Finish Date: 5-16-02	
Well ID: C3926	Well Name: 299-E17-25		
Location: SW of Purex on 200E Fence/line		Project: CY 2002 ILAW Drilling	
Prepared By: L.D. Walker	Date: 5-16-02	Reviewed By: CS Walker	Date: 5/23/02
Signature: <i>L.D. Walker</i>		Signature: <i>CS Walker</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
		150	
			230' → 235'
		235' → 240'	SAND
		240' → 243'	Gravelly SAND
		243' → 259'	Sandy GRAVEL
		259' → 275'	SAND
		275' → 382.5'	Sandy GRAVEL

Original to: Document & Information Services, H0-09/HWIS

Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

WELL SUMMARY SHEET					
Well ID:	C 3926	Location:	Suv of Purex on R00E fence/line	Project:	CY 2002 ILAW Drilling
Prepared By:	L.D. Walker	Date:	5-16-02	Reviewed By:	C.S. Walker
Signature:	[Signature]	Signature:	[Signature]	Date:	7/24/02
CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description	
1/4" Bentonite pellets: 316.0' → 326.8'		300		Sandy GRAVEL 275' → 382.5': 8" 	
Colorado Silica Sand: 10-20 mesh 326.8' → 382.5'		325			
Well Screen: 4" ID 304L Stainless Steel Cont. wire wrap O.O20-in slot 336.56' → 371.57'		350			
Tailpipe / Sump: 4" TD 304/304 SS with welded endcap 371.57' → 373.58'		375			
Total length of stainless steel well is 375.58'		400		TD = 382.5' Water level = 337.62' (5-16-02)	
All depths are in feet below ground surface.					
All temporary casing was removed from ground.					

Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BH-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

WELL SUMMARY SHEET		Start Date: 5-1-02	Page: 1 of 3
		Finish Date: 5-10-02	
Well ID: C 3828	Well Name: 299-E17-24		
Location: SW of Purex on 200E Fence/line	Project: CY 2002 ILAW Drilling		
Prepared By: L.D. Walker	Date: 5-10-02	Reviewed By: CC Wright	Date: 4/15/02
Signature: <i>L.D. Walker</i>		Signature: <i>CC Wright</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
Portland Cement Grout: 0' → 9.5'		0	0 → 1.5': Crushed rock drill pad
			1.5' → 9': Slightly Silty SAND
		25	9' → 13': SAND
			13' → 33': Slightly Silty SAND
		50	
			33' → 234': SAND
		75	
		100	
		125	
Granular Bentonite: 9.5' → 330.0'			
All temporary drill casing removed from the ground			
Depths are in feet below ground surface			

Original to: Document & Information Services, H0-09/HWIS
 Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Appendix A - Well Summary Sheets

Original to: Document & Information Services, H0-09/HWIS
Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

Well Summary Report: 2002 ILAW Well Installation
June 2002

Appendix A - Well Summary Sheets

BHI-01647

Rev. 0

WELL SUMMARY SHEET		Start Date: 5-1-02	Page: 3 of 3
Well ID: C3828		Well Name: 299-E17-24	
Location: SW of Purex on 200E Fence line		Project: CY 2002 ILAW Drilling	
Prepared By: L.D. Walker	Date: 5-10-02	Reviewed By: CS Walker	Date: 5/28/02
Signature: <i>[Signature]</i>		Signature: <i>[Signature]</i>	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
Silica Sand: 330.0' → 383'		300	
		325	318' → 325': GRAVEL
			325' → 383': Sandy GRAVEL
		350	
		375	
			TD = 383'
		400	Water level 341.3' 5-6-02
			Note: this borehole not straight enough to complete as a well. Deeper than expected water level probably due to off-vertical borehole.

Original to: Document & Information Services, H0-09/HWIS

Distribution by DIS: Environmental Technologies Well Coordinator, H0-02

BHI-EE-189 (02-20-2002)

Well Summary Report: 2002 ILAW Well Installation

June 2002

A-12

APPENDIX B

BOREHOLE LOG SHEETS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: <u>1</u> of <u>13</u>
					Date: <u>3/27/02</u>
Well ID: <u>C3826</u>		Well Name: <u>299-E17-22</u>		Location: <u>SW of Purex / 200E</u>	
Project: <u>CY 2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample Type & No.	Blows & Recovery	Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0 → 0.5': 8" Crushed Gravel	Diesel Hammer
				Drill pad surface	9"X6" dual wall casing
				0.5' → 6': Silty SAND (mS)	α, β, γ < detectable
				70% Sand (Fn-v.Fn) 30% Silt	
5	Grab Sample			10 YR 5/3 (brn) sl moist, well sorted, predom qtz/Feld; no rxn HCL	5 Ft: 1 pint grab sample for archive
				6' → 216': SAND (S)	
				tr-5% Gravel, 95-100% Sand, tr silt. Gravel R-SR Fn peb,	8.0' → 12.5': Split
10	Split Spurn #1	80% rec.		mainly basalt. Sand SA, salt-n-pepper appearance, 30% v.cse-cse, 40% med,	spurn #1 for P/N/L analysis
	Shoe			30% FA-v.Fn; 10 YR 5/2 (grayish brown)	10': Grab for archive
	Split Spurn #2	90% rec.		dry; 40% basalt, 60% qtz/Feld	12.0' → 16.5': Split
15	Shoe			no rxn HCL.	Spurn #2
	Split Spurn #3	100% rec.		16': sand predom med-fn	15': Grab for archive while driving casing.
	Shoe - Grab Samp.			Sand med-v.cse	16.0' → 20.5': Split
20	Split Spurn #4	75% rec.			Spurn #3.
				Sand very loose, dry	20': Grab for archive
	Shoe - Grab				α, β, γ < detect.
25	Split Spurn #5	80% rec.			20.5' → 25.0': Split
					Spurn #4
					25': Grab for archive
					25.0' → 29.5': Split
					Spurn #5
Reported By: <u>L.D. Walker</u>				Reviewed By: <u>C.S. Walcott</u>	
Title: <u>Geologist</u>				Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>		Date: <u>3-29-02</u>		Signature: <u>C.S. Walcott</u>	
				Date: <u>5/10/02</u>	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 2 of 13
					Date: 3-29-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 E	
Project: CY 2002 ILAW Drilling			Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL					
Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level					
30	Shoe-Grab	SS #5			Diesel hammer
	Split Spoon #6	90% rec.		SAND (S) - similar to above.	9" x 6" dual wall casing.
				100% sand, tr silt. 10% v. csc,	30' : Grab for archive
				30% csc, 30% med, 30% fn-v.fn	29.5' → 34.0' : Split Spoon #6
	Shoe			10YR 5/2 (grayish brown) dry - salt	
35	Split Spoon #7	80% rec.		and pepper look; med sorted; SA -	
				Angular; 30-40% basalt, 60-70% gtz/	35' : Grab sample for archive while advancing the casing.
	Shoe			Feld / other; tr mica; no rxn HCL	
40	Split Spoon #8	100% rec.		Sand is loose and dry	34.0' → 38.5' : SS #7
	Shoe			Slight increase in moisture content	38.0' → 42.5' : SS #8
	Split Spoon #9	100% rec.			40' Grab sample when advance casing.
45					
	Shoe				42.5' → 47' : SS #9
	Split Spoon #10	100% rec.			45' Grab / archive
50					
	Shoe				47' → 51.5' : SS #10
					50' grab - archive
				decrease in sand size - predom med-fn	
55	Grab				55' : Grab - archive
					58.0' → 62.5' : Split spoon #11
	SS #11	100% rec.			

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature: <i>[Signature]</i>	Date: 3-29-02	Signature: <i>[Signature]</i>	Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 3 of 13	
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200E		
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample Type & No.	Blows & Recovery	Graphic Log	Sample Description	Comments:	
				Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level	
60-61	Split Spoon #11	100% rec.		SAND (S) - as above	Diesel Hammer 9"x6" dual wall 60': Grab sample for archive	
65-66	Split Spoon #12	100% rec.		SAND (S) similar to above 100% sand, tr silt 10% v.cse, 40% cse, 40% med, 10% fn - v.fn. 10 YR 6/2 (lt. brownish gray)	63.5' → 68': Split Spoon #12 for PNM analysis 65': Grab for archive	
70-71	Split Spoon #13	100% rec.		dry, med sorted, SA-Angular, 30% basalt, 70% qtz/feld, other; tr mica - weak rxn HCL at edges of sample, light colored fines	68.0 → 72.5': Split Spoon #13. Waste Charact. sample from the drive shoe	
75-76	Split Spoon #14	100% rec.		74-75': possible bedding < 1cm thick in liner samples; or possibly just compaction from driving sampler.	70': Archive Grab 72' → 76.5': SS #14 75': Archive Grab 76.5' → 81.0': SS #15	
80-81	Split Spoon #15	100% rec.			Archive grab for 80' from shoe	
	Shoe - Archive					
						α, β, γ < detect.
85-86	Grab - Archive				At 85', cemented sand fragments weak rxn HCL - possible soil horizon? tr clay ⇒ check archive sample	85': Grab sample for archive
					Sand - similar to above	

Reported By: L.D. Walker	Reviewed By: C.S. Walker
Title: Geologist	Title: Geologist
Signature: <i>L.D. Walker</i>	Signature: <i>C.S. Walker</i>
Date: 4-1-02	Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 4 of 13
					Date: 4-1-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200E	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
90	Grab-Archive			SAND (S) similar to above	Diesel Hammer
	Diesel hammer ↓			100% sand, tr silt; 20% v.cse	9" by 6" dia/well casing.
				30% cse, 30% med, 20% fn-v.fn.	90': Grab-archive
				10YR 6/2 (lt. brownish gray) dry,	
95	Grab-Archive			mod sorted, SA-A; 30% basalt, 70%	95': Grab-archive
				qtz/other, tr mica; predom. no rxn HCL	
	Split Spoon #16	100% rec.		occasional weak rxn	96.0' → 100.5': SS#16
					100': Archive sample
100	Shoe-Archive			Sand med-Fine	100': Archive sample
105	Grab-Archive			105': Archive sample	
				α, β, γ < detect.	
110	Grab-Archive			SAND (S) similar to above	110': Archive sample
				25% v.cse, 30% cse, mineralogy	
				as above, no rxn HCL	
115	Grab-Archive				115': Archive sample

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature: <i>L.D. Walker</i>	Date: 4-1-02	Signature: <i>C.S. Walker</i>	Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 5 of 13
					Date: 4-1-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 E	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
120	Split Spoon # 17	100% rec.		SAND (S) similar to above 100% sand, to silt	Diesel Hammer 9" x 6" dual wall casing
	Shot			122' : Sand Fm - V. Fm, back to predom cse by 123'	119.0' → 123.5' : Split Spoon # 17
125	Grab - Archive				120' : Archive grab sample
					125' : Archive grab sample
130	Grab - Archive				130' : Archive sample
				SAND (S) 100% Sand Salt and pepper appearance cse - med, SA - Angular 30-35% basalt, tr mica Max size ~ 2mm; mostly no rxn to HCl - occasional very weak rxn	
135	Grab - Archive				135' : Archive sample
140	Grab - Archive				140' : Archive sample
145	Grab - Archive			SAND - as above	145' : Archive sample

Reported By: L.D. Walker		Reviewed By: C.S. Waight	
Title: Geologist		Title: Geologist	
Signature: <i>L.D. Walker</i>	Date: 4-1-02	Signature: <i>C.S. Waight</i>	Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: <u>6</u> of <u>13</u>
					Date: <u>4-2-02</u>
Well ID: <u>C3826</u>		Well Name: <u>299-E17-22</u>		Location: <u>SW of Purex / 200 E</u>	
Project: <u>CY 2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
150	Split Spoon #18	95% rec.		SAND (S) similar to above	Diesel hammer; 9"x 6" dual wall casing
	Shoe			100% Sand, tr silt	
				20% cse - v. cse, 40% med, 40% fn, 20% v. fn	149.0' → 153.5': Split
				20% v. fn; overall 10YR 6/2 (lt. brownish gray) dry; loose in split spoon liners,	Spoon #18 for PNNL analysis
155	Grab-Archive			mod-well sorted, SA-A, 20-30% basalt, other gtz/feld, tr mica	150': Grab sample for archive
				no rxn HCl	155': Grab-archive
					160': Grab-archive
160	Grab-Archive			Sand - slightly coarser than above	
					163.5' → 168.0': SS #19
					165': Grab-archive
165	Split Spoon #19	90% rec.			168.0' → 172.5': SS #20
	Shoe			SAND (S) slightly finer than above	172.0-172.5' (shoe) - Waste Charact. Sample
				95-100% Sand, tr 5% silt.	HEIS #: B14975, B14986
				10% v. cse - cse, 40% med, 30% fn, 20% v. fn	
170	Split Spoon #20	100% rec.		10YR 6/2 (lt. brownish gray) dry, mod-well sorted, SA-A; 30% basalt, 70% gtz/feld/other, tr mica; weak HCl rxn.	170': Grab-archive
	Shoe				172.5' → 177.0': SS #21
175	Split Spoon #21	90% rec.			175': Grab-Archive
	Shoe				
				178': tr v. fn pebble	

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>C.S. Walker</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>LD Walker</u>	Date: <u>4-3-02</u>	Signature: <u>C.S. Walker</u>	Date: <u>5/10/02</u>

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 7 of 13
					Date: 4-3-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
180	Split Spoon #22	100% rec.		SAND (S) similar to above 95-100% sand, tr-5% silt 10% v.cse, 20% cse, 40% med, 30% fn-v.fn. 10YR6/2 (lt. brn gray) dry to sl moist; salt & pepper look; med sorted; SA-A; ~30% basalt, 70% gtz/other, tr mica, no rxn HCl max size ~2 mm	Diesel hammer; 9" by 6" dual wall casing
185	Grab-Archive				179.0' → 183.5': Split Spoon #22
190	Grab-Archive				180': Grab sample for archive when casing is advanced
195	Grab-Archive				185': Grab-archive
200	Grab-Archive				190': Grab-archive
205	Grab-Archive				195': Grab-archive
					200': Grab-archive
					201': tr small caliche fragment
					205': Grab-archive
					205' sand sl moist
Reported By: L.D. Walker			Reviewed By: C.S. Walker		
Title: Geologist			Title: Geologist		
Signature:		Date: 4-3-02	Signature:		Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 8 of 13
					Date: 4-3-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Putex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
210	Grab-Archive			SAND(S) similar to above	Diesel hammer; 9"x 6" dual wall casing
				100% sand, tr silt	
				predom med - fn.	210': Grab sample for archive
215	Grab-Archive			216' → 224': Gravelly SAND (gs)	215': Grab - archive
				10-15% Gravel, 85-90% Sand, tr silt.	
				Gravel med- v. fn peb, predom basalt, SR-SA; Sand similar to above.	219.0' → 223.5': Split Span #23
220	Split Spoon #23	100% rec.			220': Grab - archive
	Shoe			Sand is predom cse-v.cse, ~50% basalt	
225	Grab-Archive			Gravel content decrease to ~5%	225': Grab - archive
				224' → 231: SAND (S)	
			tr-5% Gravel, 95-100% Sand,	230': Grab-archive	
230	Grab-Archive		tr-5% Silt.		
			231 → 238': Gravelly SAND (gs)		
			20-30% Gravel, 70-80% Sand, tr silt		
			Gravel med to v. fn peb, Sand predom	235': Grab - archive	
235	Grab-Archive		cse to med. 10YR5/2 (grayish brown) dry; poorly sorted; Gravel SA-SR, sand SA		
			Gravel 40-50% basalt, 50-60% granitic/ gneiss; HCL rxn weak to none		
Reported By: L.D. Walker				Reviewed By: L.S. Walker	
Title: Geologist				Title: Geologist	
Signature: [Signature]		Date: 4-3-02		Signature: [Signature] Date: 7/10/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 9 of 13
					Date: 4-3-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
240	Grab-Archive			238' → 274': SAND (S)	Diesel hammer; 9"
	Diesel hammer			tr 5% Gravel, 95-100% Sand, tr silt.	by 6" dual wall casing
				Gravel v. fn peb; Sand 20% v. cse, 20% cse,	
				30% med, 30% fn-v. fn. 10YR 5/2 (gr brn)	240': Grab sample
				dry, mod sorted, SA-A; 30-40% basalt,	For archive
				60-70% qtz/other	
245	Grab-Archive			245': tr cse peb to small cobble	245': Grab-archive
					250': Grab-archive
250	Grab-Archive				
				SAND (S) similar to above.	255': Grab-Archive
				100% Sand, tr gravel (fn peb)	
				tr silt	
255	Grab-Archive			30% v. cse-cse, 40% med, 30% fn-v. fn.	
				10YR 5/2, "Salt-n-Pepper", dry, mod sort,	
				SA-A, 35% basalt, 65% qtz/feld/other,	
				tr mica, max size ~ 2mm, no rxn HCl	
					260': Grab-Archive
260	Grab-Archive				
					265': Grab-Archive
265	Grab-Archive			SAND (S) similar to above	
				100% sand, tr silt	
				predom cse-med, sl moist, mod-	
				well sorted, SA-A, 40% basalt	
				no rxn. HCl	
Reported By: L.D. Walker				Reviewed By: C.S. Walbert	
Title: Geologist				Title: Geologist	
Signature: <i>L.D. Walker</i>		Date: 4-4-02		Signature: <i>C.S. Walbert</i>	
				Date: 5/10/02	

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 10 of 13
					Date: 4-4-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
270	Grab-Archive			SAND - s/l moist	Diesel hammer; 9" by 6" dual wall casing
	Diesel hammer ↓				
				274' → 279' : Gravelly SAND	270': Grab sample for archive
275	Grab-Archive			(gS) 20% Gravel, 80% Sand, tr silt. Gravel med-Fn peb, SR, Sand	275': Grab-archive
				med-cse. 30-40% basalt, 60-70% qtzite, granitic/other, poorly sorted, no rxn HCl	
280	Grab-Archive		279' → 283' : SAND (S)	280': Grab-archive	
			tr gravel, 100% Sand		
			Similar to sand above; med-cse, salt-n-pepper		
			dry to s/l moist		
			283' → 293' : Gravelly SAND		
285	Grab-Archive		(gS) 20-25% Gravel, 75-80% Sand, tr silt. Gravel med-cse peb, tr v.cse peb to sm cobble. Sand as above.	285': Grab-archive	
			Gravel SR, 40-50% basalt, 50-60% qtzite/		
			granitic/other med-cse , poorly sorted,		
290	Grab-Archive		no rxn HCl; overall color 10YR5/2 (grayish brown), dry.	290': Grab-archive	
			293' → 302' : Sandy GRAVEL		
295	Grab-Archive		(SG) 70% Gravel, 25-30% Sand, tr-5% silt. Gravel tr cobble, 30% v.cse peb, 40% cse, 30% med-Fn.	295': Grab-archive	
			poorly sorted, dry, basalt/Qtzite/granitic	drill rate slows - air lost into formation	
			no rxn HCl		
Reported By: L.D. Walker				Reviewed By: CS WR16-5	
Title: Geologist				Title: Geologist	
Signature: <i>L.D. Walker</i>		Date: 4-4-02		Signature: <i>CS WR16-5</i>	
				Date: 5/10/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 11 of 13
					Date: 4-4-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
300	Grab - Archive			Gravel percentage and sizes increasing; a lot of air circulation lost into formation during drilling.	Diesel hammer; 9" by 6" dual wall casing
	diesel hammer ↓			302' → 352': GRAVEL (G)	300': Grab - archive
305	Grab - Archive			80-85% Gravel, 15-20% Sand, tr silt	
				306': drill has to break up basalt boulder of unknown size	305': Grab - archive
				Gravel tr lg. cob- boulder, 10% sm cobble, 30% v. csc pnb, 30% csc, 30%	
310	Grab - Archive			med-v. fn; Sand med-fn; gray, dry; poorly sorted; gravel R-SA; basalt 30-40%, other qtzite, granitic, no rxn HCl	310': Grab - archive
				Sand fn-v. fn, predom. qtz	
315	Grab - Archive				315': Grab sample for archive
				~318': basalt boulder	
				Air lost into formation - open framework (slow drill rate) gravel?	
320	Grab - Archive		Cobbles of ~10 cm common	320': Grab sample - archive	
			324': increase in silt.	322': first wet gravel to surface	
325	Grab - Archive		~80% Gravel, 10% fn-v. fn sand, 10% silt	325': Grab - archive	
Reported By: L.D. Walker				Reviewed By: CS Weibert	
Title: Geologist				Title: Geologist	
Signature:		Date: 4-10-02		Signature:	
				Date: 5/10/02	

Original to: Document and Information Services, HO-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 12 of 13
					Date: 4-10-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
330	Grab-Archive			GRAVEL (G) similar to above; water production increasing	Diesel hammer 9" x 16" dual wall casing
335	Grab-Archive			85-90% Gravel, 10-15% Sand, tr silt. Gravel 25% cobble, 30% v. cse peb, 25% cse peb, 20% med-fn; Sand predom fn-v. fn. Multicolored, wet, poorly sorted; most gravel SR-R; random mix basalt, qtzite, granitic, other tr fragments lg cobbles;	330': Grab sample for archive
340	Grab-Archive			335-340' Sand med to cse sized	340': Grab-Archive
				no cementation noticed on gravels	With casing shoe at 339', WL = 322.3' bgs
345	Grab-Archive			Gravel - similar to above.	345': Grab-Archive
				349-350': drilling indicates lg cobbles/ possible boulders	350': Grab-Archive
350	Grab-Archive			Sand increasing...	~352': possible Hanford / Ringold Fm contact(?)
				352' → 363': Sandy GRAVEL (sG) 70-75% Gravel, 25-30% Sand tr silt. Gravel similar to above	355': Grab-Archive
355	Grab-Archive			Sand med-cse, SA; 60% qtz, 40% basalt, tr mica (limonite) w	
				Sand is med-fn, 80% qtz/20% basalt or other	
Reported By: L. D. Walker				Reviewed By: AS 4/21/02	
Title: Geologist				Title: Geologist	
Signature:		Date: 4-10-02		Signature:	
				Date: 5/10/02	


Original to: Document and Information Services, H0-09/HW1S


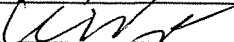
BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 13 of 13
					Date: 4-10-02
Well ID: C3826		Well Name: 299-E17-22		Location: SW of Purex / 200 East	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
360	Grab-Archive			Sandy GRAVEL (sG) As described above. 361' : drilling indicates lg cobbles	Diesel Hammer 9"x16" dual wall casing
365				TD = 363' bgs	360' : Grab-Archive
				4-11-02 Depth to water = 322.1' , with casing shoe at 362.5'	
370					
375					
380					
385					
				Not used CSW	

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature: 	Date: 4-11-02	Signature: 	Date: 6/10/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 1 of 13
					Date: 4-17-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, along 200E Fence	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
0				0' → 1.5' : Sandy GRAVEL Crushed rock drill pad	Diesel Hammer 9" x 6" Dual Wall casing
5	Grab-Archive			1.5' → 8' : Silty SAND (mS) tr- 5% Gravel, 65-70% Sand, 30% Silt. Sand predom v. fn; SA-A, 80-90% qtz; 10-20% basalt, other 10YR4/3 (brown) sl moist; mod rxn to HCL.	5': Grab sample for archive
10	Grab-Archive			8' → 23' : SAND (S) 100% Sand, tr silt. Med-cse, 70-80% basalt, 20-30% qtz/other. 10YR3/1 (v. dk gray), moist, well sorted, SA; tr weak rxn HCL	10': Grab-archive
15	Grab-Archive			Size gradual decrease; predom med by 15' → 50-60% basalt, no rxn HCL.	15': Grab-archive
20	Grab-Archive			20' : Gravel tr- 5% predom v. fn - fn peb	20': Grab-archive
25	Grab-Archive			23' → 29' : Gravelly SAND (gS) 10-20% Gravel, 80-90% Sand tr silt. Gravel v. fn - med peb, SA-SR Sand similar to above.	25': Grab-archive
				gravel content decrease to ~ 5%	
Reported By: L.D. Walker				Reviewed By: CS Wright	
Title: Geologist				Title: Geologist	
Signature: [Signature]		Date: 4-17-02		Signature: [Signature] Date: 5/14/02	

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 2 of 13	
					Date: 4-17-02	
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, along 200E Fence		
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level	
	Type & No.	Blows & Recovery				
30	Grab-Archive			29' → 233': SAND (S) + 5% Gravel, 95-100% Sand, + silt. Gravel v. fn. peb, SA-SR, Sand 20% v.csc, 30% csc, 30% 40% med, 10% fn-v.fn. 10YR 5/2 (gry brn) sl. moist, med-well sorted, 40-50% basalt, 50-60% qtz, Salt and pepper appearance. max size 3-4 mm, no rxn HCL	Diesel Hammer 9"x6" dual wall casing 30': Grab-archive	
35	Grab-Archive				35': Grab-archive	
40	Grab-Archive				40': Grab-archive	
					45': Grab-archive	
45	Grab-Archive				SAND - similar to above 100% Sand, + v.fn pebble	
					50': Grab-archive	
50	Grab-Archive					
55	Split Spun #1	80% rec.			SAND (S) similar to above + silt	53.5' → 58.0': Split Spun #1, for PNNL analysis
	Shore Split Spun #2					55': Grab-archive
Reported By: L.D. Walker				Reviewed By: CS Walker		
Title: Geologist				Title: Geologist		
Signature: RD Walker		Date: 4-17-02		Signature: [Signature] Date: 5/14/02		

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 3 of 13
					Date: 4-17-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, along 200E Fence	
Project: CY 2002 ILAW Drilling			Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
60	SS #2	100% rec.		SAND (S) similar to above tr gravel, 100% Sand, tr silt.	Diesel hammer 9" by 6" dual wall casing
	Shoe			Gravel Fm peb, R-SR basalt	
65	SS #3	100% rec.		Sand v. cse - Fm; 10YR 6/2 (lt. brownish gray) dry to sl moist; med sorted, SA-; 30-40% basalt, 60-70% qtz/feld	58.0' → 62.5': Split Spoon #2
	Shoe			tr iron oxide, tr med-strong rxn to HCl	60': Grab-archive
70	Grab-Archive				62.5' → 67.0': Split Spoon #3
				SAND - as above	65': Grab-archive
					70': Grab-archive
75	Grab-Archive				75': Grab-archive
	Split Spoon #4	100% rec.			78.0' → 80.5': Split Spoon #4
80	Shoe	archive sample			Archive - 80'
			80': Sand fine to very fine 100% Sand. 10% cse-med, 50% Fine, 40% v. Fm. 10YR 5/2 (grayish brn) sl moist, med-well sorted; SA; 20-30% basalt, 70%-80% qtz/feld/other tr mica, tr FeOx, no visible rxn HCl.	85': Grab-Archive	
85	Grab-Archive				

Reported By: L.D. Walker		Reviewed By: CS Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 4-17-02	Signature:	Date: 05/14/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG						Page: 4 of 13		
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, along 200E Fence				
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface				
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:			
	Type & No.	Blows & Recovery			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level		
90	Grab-Archive			SAND (S) similar to above tr v. fn pebble, 100% Sand v. fn peb SA, predom basalt; Sand 20% v.cse, 30% cse, 30% med, 20% fn. 10YR5/2 (greyish brn) sl moist, med sorted; SA-A; ~30% basalt, 70% qtz/other tr mica; max size ~4 mm tr weak rxn HCL.	Diesel hammer 9" by 6" dual wall casing			
95	Grab-Archive				90': Grab-archive			
					95': Grab-archive			
100	Split Spoon #5	100% rec.			(Salt & pepper)	98.0' → 102.5': Split Spoon #5		
	Shoe					100': Grab-archive		
105	Grab-Archive				SAND (S) similar to above predom medium size	105': Grab-archive		
110	Grab-Archive					110': Grab-archive		
115	Grab-Archive				Sand - med to cse, moist	115': Grab-archive		

Reported By: L.D. Walker

Reviewed By: CS Wright

Title: Geologist

Title: Geologist

Signature: [Signature]

Date: 4-17-02

Signature: [Signature]

Date: 5/14/02

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 5 of 13
					Date: 4-17-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, along 200E Fence	
Project: CY2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
120	Split Spoon #6				Diesel hammer
	Shoe				119.0' → 123.5': Split Spoon #6
125	Grab-Archive			SAND (s) similar to above	120': Archive grab
				tr v. fn peb, 100% Sand, tr silt	
				Sand 10% v.cse, 20% cse, 40% med,	125': Grab-archive
				20% fn, 10% v.fn; 10YR 5/3 (brown)	
				streakist, med sorted; 20% basalt, 80% qtz/	
				other, tr mica, weak rxn HCl	130': Grab-archive
130	Grab-Archive				
				134': moisture content dropping	135': Grab-archive
135	Grab-Archive		SAND, med-cse, SA-A		
			slightly more basalt than above		
				140': Grab-archive	
140	Grab-Archive		SAND (s)		
			tr v. fn peb - fn peb ⇒ usually		
			basalt, 100% Sand v.cse to fn		
			SA-A, 20-30% basalt, 70-80% qtz/	145': Grab-archive	
145	Grab-Archive		other, tr mica, tr iron oxide		
			staining, very weak rxn to HCl.		
			Dry.		
				149': end of 4/17/02	
Reported By: L.D. Walker				Reviewed By: CS LRP/BLT	
Title: Geologist				Title: Geologist	
Signature:		Date: 4-17-02	Signature:		Date: 5/14/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: <u>6</u> of <u>13</u>
					Date: <u>4-18-02</u>
Well ID: <u>C3827</u>		Well Name: <u>299-E17-23</u>		Location: <u>SW of Purex, on 200E Fence/line</u>	
Project: <u>CY2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample Type & No.	Blows & Recovery	Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	Split Spoon #7	90% rec.	-	SAND (S) tr v. fn. peb, 95-100% Sand, tr-5% silt. 30% v.cse-cse, 40% med, 30% fn-v. fn. 10YR6/2 (lt. brownish gray) dry; mod sorted, SA-A, 20-30% basalt, max size 3-4 mm, mod rxn HCL.	Diesel hammer, 9" by 6" dual wall casing
	Shoe				
155	Split Spoon #8	100% rec.			149.0' → 153.5': Split Spoon #7 150': Grab-archive
	Shoe				
160	Split Spoon #9	100% rec.			153.5' → 158.0': Split Spoon #8 155': Grab-archive
	Shoe				
165	Split Spoon #10	95% rec.			158.0' → 162.5': Split Spoon #9 160': Grab-archive
	Shoe				
					162.5' → 167.0': Split Spoon #10 165': Grab-archive.
170	Grab-Archive				SAND (S) similar to above 100% Sand, tr silt 10% v.cse, 30% cse, 40% med, 20% fn- v. fn. 10YR6/2 (lt. brownish gray) dry; mod sorted, SA; 30% basalt, 70% to well qtz/feld/other, tr iron oxide max size ~ 2mm; weak rxn HCL.
175	Grab-Archive				175': Grab-archive

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>CS CRR16WT</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>	Date: <u>4-18-02</u>	Signature: <u>[Signature]</u>	Date: <u>5/1/02</u>

Original to: Document and Information Services, H0-09/HWIS

BOREHOLE LOG					Page: 7 of 13
					Date: 4-18-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, on 200E Fence line	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
180	Split Spoon #11	100% rec.		SAND (S) similar to above	Diesel hammer
				95-100% Sand, tr-5% silt	9" by 6" dual wall casing
	Shor			25% v.cse-cse, 35% med, 40% fn-	
				v.fn.; light brownish gray, dry;	179.0' → 183.5': Split
185	Grab-Archive			med-well sorted, SA-A, ~30%	Spoon #11
				basalt, 70% gtz/feld, tr mica, tr	180': Grab-archive
				iron oxide staining; very weak	
				rxn HCl	185': Grab-archive
190	Grab-Archive				190': Grab-archive
195	Grab-Archive			SAND - as above	
				similar salt and pepper	195': Grab-archive
				salt and pepper appearance.	
200	Grab-Archive			SAND (S)	200': Grab-archive
				similar to above	
				slightly coarser, slightly	
				higher basalt percentage.	
				very weak rxn HCl	
205	Grab-Archive				205': Grab-archive

Reported By: L.D. Walker		Reviewed By: CS Walker	
Title: Geologist		Title: Geologist	
Signature: L.D. Walker	Date: 4-18-02	Signature: CS Walker	Date: 5/14/02

B-20

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 8 of 13
					Date: 4-18-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, on 200E Fence	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
210	Grab-Archive			SAND (S) similar to above	Diesel hammer; 9" by 6" dual wall casing
				100% sand, tr silt	
				20% v.cse-cse, 30% med, 40% Fn,	
				10% v. Fn. 10YR 6/2 (lt. brownish grey)	210': Grab sample
215	Grab-Archive			dry; med-well sorted, SA-A,	For archive
				20-30% basalt, 70-80% qtz/feldspar	
				tr mica, max size ~ 2mm	215': Grab-archive
				very weak rxn HCL.	
220	Split Spoon #12	90% rec.			219' → 223.5': Split Spoon #12
	Shoe				220': Grab-archive
225	Grab-Archive			225': Grab-archive	
			occasional v.fn-fn pebbles		
			225 → 233: sand with 5-10% gravel	230': Grab-archive	
230	Grab-Archive			predom. fn peb. sand cse-v.cse	
			233': Gravel increase		
			233' → 236': Sandy GRAVEL (SG)		
			70% Gravel (v.fn-med peb) 30% Sand	235': Grab-archive	
			(cse-v.cse sand) Gravel 60-70% basalt, SA to angular.		
235	Grab-Archive			237': tr cobble, then more sand	
			236': back to SAND		
Reported By: L.D. Walker				Reviewed By: CS Walker	
Title: Geologist				Title: Geologist	
Signature: <i>L.D. Walker</i>		Date: 4-19-02		Signature: <i>CS Walker</i> Date: 5/17/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 9 of 13	
					Date: 4/19-02	
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, on 200E Fence line		
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level	
	Type & No.	Blows & Recovery				
240	Grab-Archive			236' → 254': SAND (S) 5-10% Gravel, 90-95% Sand. Sand 5% v.cse, 40% cse, 30% med, 25% fn. Gravel v.fn - fn peb. 10YR 6/2 (lt. brownish gray) dry; mod/well sorted, SA-Ang, 30-40% basalt, 60-70% gtz/other, tr mica very weak rxn HCL. 248': single gause egg (qtzite) in sand	Diesel hammer; 9" by 6" dual wall casing 240': Grab-archive	
245	Grab-Archive			245': Grab-archive		
250	Grab-Archive			250': Grab-archive		
255	Grab-Archive			254' → 257': Gravelly SAND (gS) 20-30% Gravel (v.fn - fn peb, A-SA, basalt) 70-80% Sand (similar to sand above) weak HCL rxn	255': Grab-archive	
260	Grab-Archive			257' → 260': SAND (S) with ~5% fn peb. 260' → 264': Gravelly SAND (gS) 25% Gravel (v.fn - fn peb) 75% Sand 40-50% basalt, SA-A, weak rxn HCL	260': Grab-archive	
265	Grab-Archive			264' → 268': Sandy GRAVEL (sG) 40% Gravel, 55% Sand, 5% silt. Gravel fn-med peb; predom. basalt, SA. Sand v.cse - v.fn; poorly sorted Gravel size decrease from 264 to 268 ft.	265': Grab-archive	
Reported By: L.D. Walker				Reviewed By: CS Walker		
Title: Geologist				Title: Geologist		
Signature:		Date: 4-19-02		Signature:		
				Date: 5/23/02		

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)


Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 10 of 13
					Date: 4-19-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, on 200E fence line	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
270	Grab-archive			268' → 272': Gravelly SAND (gS) 20% Gravel (v. fn - med peb., mainly basalt) 80% Sand (v. cse - fn, 30% basalt, 70% qtz/other, SA-A)	Diesel hammer 9" by 6" dual wall casing.
275	Grab-archive			272' → 281': Sandy GRAVEL (sG) 40-50% Gravel, 50-60% Sand, +silt. Gravel mostly fn - v. fn peb.; Sand v. cse to med, SA-A; Gravel up to 50% basalt; poorly sorted; weak rxn HCL - occas.	270': Grab sample for archive 275': Grab-archive
280	Grab-Archive			281' → 284': GRAVEL (G) 80-90% Gravel, 10-20% Sand drilling indicates lg cobble to boulder size; air lost into formation.	280': Grab-archive
285	Grab-Archive			284' → : Sandy GRAVEL (sG) 50-55% Gravel, 40% Sand to 45%, +5% silt; Gravel fr cobble, 10% v. cse peb, 40% cse peb, 40% med peb, 10% fn - v. fn; Sand mainly cse - med. 10YR 6/2 (lt. brownish gray) dry, poorly sorted; Gravel SA-SR; 20-30% basalt, 70-80% qtzite/granitic/other; weak rxn HCL.	285': Grab-archive
290	Grab-Archive				290': Grab-archive
295	Grab-Archive				295': Grab-archive

Reported By: L.D. Walker		Reviewed By: CS Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 4-19-02	Signature:	Date: 5/23/02

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: <u>11</u> of <u>13</u>
					Date: <u>4-19-02</u>
Well ID: <u>C3827</u>		Well Name: <u>299-E17-23</u>		Location: <u>SW of Purex, 200 E. Fence line</u>	
Project: <u>CY 2002</u>		<u>ILAW Drilling</u>		Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
300	Grab-Archive			Sandy GRAVEL (SG) 40% Gravel, 60% Sand; weak HCL rxn	Diesel hammer; 9" by 6" dual wall casing
				302': large cobbles/boulders	
				Sand predom cse.	300': Grab sample for archive.
305	Grab-Archive			60-70% Gravel, 30-40% Sand, tr silt	
				Gravel cse-med peb, R-SR; 40% basalt	
				60% granitic/Qtzite/other. Sand med-cse,	305': Grab-archive
				30% basalt;	
310	Grab-Archive			309': drilling indicates large cobbles	
				sand content drops to ~20%	310': Grab-archive
				312': drill rate slows considerably large cobbles	
				315': Grab-archive	
315	Grab-Archive			312' → 358': GRAVEL (G) Gravel 80-90%, Sand 10-20%, tr silt. Fragments indicate up to 50% cobble, 30% v.cse peb, 20% cse-Fn peb. Sand predom Fn. Sand 80-90% Qtz, 10-20 % basalt, other. Gravel includes Qtzite, granitic, basalt, other	320': Grab-archive
320	Grab-Archive				
					325': Grab-archive
325	Grab-Archive			328': Drilling indicates no large cobbles, but more air lost into formation	

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>CS Walker</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>4-24-02</u>	Signature: <u>[Signature]</u>	Date: <u>5/23/02</u>

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 12 of 13
					Date: 4-24-02
Well ID: C3827		Well Name: 299-E17-23		Location: SW of Purex, on 200 E Fenceline	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
330	Grab-Archive			GRAVEL (G) similar to above	Diesel hammer
				80-90% Gravel, 10-20% Sand, tr silt.	9" by 6" dual wall casing
				20% sm. cob, 50% v.cse-cse peb,	330': Grab sample
				30% med-fn peb; Sand is predom	For archive.
335	Grab-Archive			med; dry becoming wet by 334';	335': Grab-archive
				when allowed to recover w.l.=332.5'	
				poorly sorted, gravel SR-Round,	
				sand SA; Gravel a mixture of	
				basalt, granitic, qtzite	
340	Grab-Archive			340': Silt tr-5%	340': Grab-archive
				with casing at 349',	
				Water level=332.5'	
345	Grab-Archive		345-350': sand content appears	345': Grab-archive	
			to increase, still at or		
			below 20%		
				350': Grab-archive	
350	Grab-Archive		GRAVEL - similar to above		
				355': Grab-archive	
355	Grab-Archive		357'→358': sand increase,		
			Gravel becomes Sandy Gravel		
Reported By: L.D. Walker			Reviewed By: CS Walker		
Title: Geologist			Title: Geologist		
Signature: AD Walker		Date: 4-25-02	Signature: CS Walker		Date: 5/23/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

BOREHOLE LOG						Page: 13 of 13	
Well ID: C 3827		Well Name: 299-E17-23		Location: SW of Putex, on 200E fence line			
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:		
	Type & No.	Blows & Recovery					
360	Grab-Archive			358' → 372': Sandy GRAVEL (SG)	Diesel hammer, 9" by 6" dual wall casing		
				60-70% Gravel, 30-40% Sand, tr silt. Gravel 10% sm cob (tr lg cob)			
				40% v.cse - cse peb, 30% med peb, 20% fn - v. fn. Sand med-fn	360': Grab-archive		
365	Grab-Archive			Gravel poorly sorted, SR-R, mix of basalt / qtzite / granitic / other.	365': Grab-archive		
				Sand 80-90% qtz, tr mica			
370	Grab-Archive			370-372', Sand med - cse	370': Grab-archive		
	Grab-Archive			TD = 372' bgs.	372': Grab-archive and T.D.		
375							
380							
385							

Reported By: L.D. Walker

Title: Geologist

Signature: *L.D. Walker*

Reviewed By: *CS Walker*

Title: *Geologist*

Signature: *CS Walker*

Date: 4-25-02

Date: 5/27/02

Original to: Document and Information Services, H0-09/HWIS

BOREHOLE LOG					Page: <u>1</u> of <u>13</u>
Well ID: <u>C 3926</u>		Well Name: <u>299-E17-25</u>		Location: <u>200 East, SW of Purex</u>	
Project: <u>CY 2002 ILAW Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
0	Diesel Hammer			0' → 1.5': Crushed rock drill pad	Diesel hammer, 9" x 6" dual wall casing.
5				1.5' → 9': Slightly Silty SAND tr gravel, 85-90% SAND, 10-15% silt Sand is med to fn; brown, sl moist, mod sorted; 70% qtz/feld, 30% basalt	
10	Grab Archive			9' → 11': Gravelly SAND (gs) 10-15% Gravel, 85-90% Sand, tr silt. grading to SAND with less than 10% gravel	10': Grab sample for archive
15				11' → 15': SAND (s) tr gravel, 100% Sand. Sand mainly cse, dark gray, moist	
20	Grab Archive			15' → 36': Slightly Silty SAND (m) S tr gravel, 85-90% Sand, 10-15% silt. 30% cse - v. cse, 40% med, 30% fn - v. fn. 10YR 4/3 (brown), moist; mod sorted, SA-A; 40% basalt, 60% qtz/feld/other, max size ~ 5 mm; mod rxn HCl	20': Grab sample for archive
25					

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>CS Wright</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>	Date: <u>5-10-02</u>	Signature: <u>CS Wright</u>	Date: <u>5/11/02</u>

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: <u>2</u> of <u>13</u>
					Date: <u>5-10-02</u>
Well ID: <u>C3926</u>		Well Name: <u>299-E17-25</u>		Location: <u>200 East, SW of Purex</u>	
Project: <u>CY 2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
30	Grab - Archive			Slightly Silty SAND - similar to above	Diesel Hammer
35				36' → 230' : SAND (s)	9" by 6" dual wall casing
				95-90% Sand, 5-10% Silt	30': Grab sample for archive
				+ gravel, 90-95% Sand, 5-10% Silt	
				gravel is v. fn peb; Sand predom cse,	
				10 YR 4/2 (dark grayish brown), moist;	
40	Grab - Archive			mod sorted; SA-A; 40% basalt,	40': Grab sample for archive
				60% qtz/feld; max size 5-10 mm;	
				mod rxn HCl.	
45				46': lumps of silt/clay in the sand with strong HCl rxn	
			SAND - similar to above.		
50	Grab - Archive		50': + gravel - med to cse peb, R	50': Grab - archive	
55			silt content decrease		

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>C.S. Walker</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>	Date: <u>5/10/02</u>	Signature: <u>C.S. Walker</u>	Date: <u>5/17/02</u>

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 3 of 13	
					Date: 5-10-02	
Well ID: C 3926		Well Name: 299-E17-25		Location: 200 E, SW of Purex		
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type & No.	Blows & Recovery				
60	Grab-Archive			SAND (s) similar to above tr gravel, 95% Sand, 5% Silt Sand med to cse; 10YR4/2 (dk. grayish brown) moist; med sorted, SA-A; 30% basalt, 70% qtz/feld/ other, tr mica; weak HCl rxn tr silt fragments with strong rxn HCl.	Diesel Hammer 9" by 6" dual wall casing	
65					60': Grab Sample For archive	
70	Grab-Archive				Silt content tr to none	70': Grab sample For archive
75						
80	Grab-Archive				SAND 100% Sand, tr silt 40% cse, 50% med, 10% fn-v.fn 10YR5/2 (grayish brown) sl moist; mod-well sorted, SA-A; 30% basalt 70% qtz/feld, tr mica; max size 2-4 mm; mod rxn HCl.	80': Grab-archive
85						
Reported By: L.D. Walker			Reviewed By: CS Walker			
Title: Geologist			Title: Geologist			
Signature:		Date: 5-10-02	Signature:		Date: 5/12/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

BOREHOLE LOG						Page: 4 of 13	
Well ID: C3926		Well Name: 299-E17-25		Location: 200 East, SW of Purex			
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface			
Depth (FL)	Sample		Graphic Log	Sample Description	Comments:		
	Type & No.	Blows & Recovery					
90	Grab - Archive			SAND (S) 100% Sand, tr gravel (fn-v.fn pbb). Sand 10% v.cse, 40% cse, 30% med, 20% fn-v.fn; 10R5/2 (gr brown), sl moist, SA-A, mod sorted, 20-30% basalt, 70-80% qtz/feld tr mica. HCl rxn weak to mod.	diesel hammer; 9" by 6" dual wall casing.		
95				tr occasional silt lumps	90': Grab sample for archive		
100	Grab - Archive			possible caliche fragments (< 1cm) v. strong HCl rxn	100': Grab sample for archive		
105				100': Sand predom med to fn			
110	Grab - Archive			SAND (S) - similar to above predom cse to med, moist, weak rxn HCl.	110': Grab - Archive		
115				114' → 116': Sand is fn-v.fn			
Reported By: L.D. Walker				Reviewed By: CS Walker			
Title: Geologist				Title: Geologist			
Signature: [Signature]		Date: 5-10-02		Signature: [Signature]		Date: 5/17/02	

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG							Page: 5 of 13	
							Date: 5-10-02	
Well ID: C3926		Well Name: 299-E17-25		Location: 200 E, SW of Purex				
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface				
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:			
	Type & No.	Blows & Recovery						
120	Grab-Archive			SAND (S) similar to above	Diesel hammer,			
	Diesel hammer			100% sand, tr silt	9" by 6" dual			
				tr gravel (v. fn peb)	wall casing			
				Sand predom med, salt and	120': Grab sample			
125				pepper appearance; moist, mod sorted,	For archive			
				SA-A; 30% basalt, 70% qtz/feld,				
				tr mica; max size ~5 mm				
				HCl rxn weak.				
130	Grab-Archive				130': Grab sample			
					For archive.			
135				~135': tr silt fragments in sand				
				137': silt fragments; ^{brown} tr moist,				
				strong HCl rxn				
140	Grab-Archive			SAND (S) similar to	140': Grab-archive			
				above. 95-100% Sand, tr-5%				
				silt Sand cse to med; 10YR5/2				
				(gr brown) moist; mod sorted,				
145				SA-A; 30% basalt, 70% qtz/				
				feld; HCl rxn weak.				

Reported By: L.D. Walker

Reviewed By: CS Walker

Title: Geologist

Title: Geologist

Signature: L.D. Walker

Date: 5-10-02

Signature: CS Walker

Date: 5/12/02

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: <u>6</u> of <u>13</u>
					Date: <u>5-10-02</u>
Well ID: <u>C 3926</u>		Well Name: <u>299-E17-25</u>		Location: <u>200 E, SW of Purex</u>	
Project: <u>CY 2002 ILAW Drilling</u>		Reference Measuring Point: <u>Ground Surface</u>			
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
150	Grab - Archive			SAND - similar to above	Diesel hammer,
	diesel hammer			100% Sand, tr silt. med to cse, moist, SA, mod-well sorted, 25-30% basalt, 70-75% qtz/feld	9" by 6" dual wall casing
155				156': sand v. cse, with tr silt	
				158': Sand med, decrease in silt.	
160	Grab - Archive				160': Grab - archive.
				Silt/clay fragments - brown, strong HCL rxn	
165				SAND (S)	
				100% Sand, predom fn. sl moist, well sorted, sub angular; 20% basalt, 80% qtz/feldspar; tr mica, mod rxn HCL.	170': Grab - archive
170	Grab - Archive				
175				176': Silt fragments	

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>C.S. Walker</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>5-10-02</u>	Signature: <u>[Signature]</u>	Date: <u>5/17/02</u>

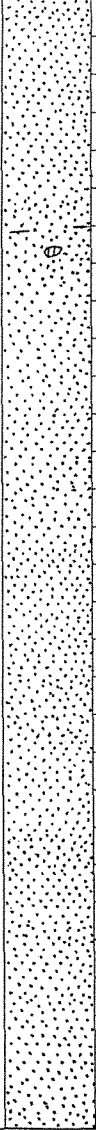
Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 7 of 13
					Date: 5-10-02
Well ID: C 3926		Well Name: 299-E17-25		Location: 200 E, SW of Purex	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Fl.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
180	Grab-Archive			SAND (S) similar to above predom fine to medium	Diesel hammer; 9" by 6" dual wall casing
185				186': single caliche fragment ~ 2 cm diameter sub round, yellowish brown. (in top of 180' archive jar)	180': Grab sample for archive
190	Grab-Archive			(fine)	190': Grab-archive
195				SAND (S) 100% sand, tr silt 20% v.cse, 20% cse, 40% med, 20% fa-v.fn. 10YR 5/2 (grayish brown) sl moist, med-well sorted, SA, 30% basalt, 70% qtz/feld, max size ~ 4 mm; weak rxn HCL	200': Grab sample for archive
200	Grab-Archive			(Coarse)	
205				sand becoming slightly drier predom med-fn	
Reported By: L.D. Walker				Reviewed By: CS Walker	
Title: Geologist				Title: Geologist	
Signature: L.D. Walker		Date: 5-10-02		Signature: CS Walker	
				Date: 5/11/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

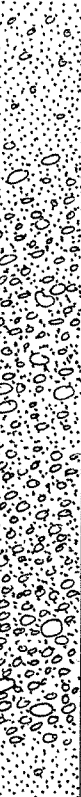
Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 8 of 13
					Date: 5-10-02
Well ID: C3926		Well Name: 299-E17-25		Location: 200 E, SW of Purex	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
210	Grab-Archive			SAND (S) similar to above	Diesel hammer, 9" by 6" dual wall casing
				100% Sand, tr silt. predom med-cse sized; 10YR5/2 (grayish brown)	
				sl moist; mod sorted; SA-A;	210': Grab sample
215				20-25% basalt, 75-80% qtz/other;	For archive
				HCl rxn weak to mod.	
				218': Sand is dry; tr fn pebbles	
				Sand v. cse sized	
220	Grab-Archive				220': Grab - archive
225					
			228': tr pebbles, fine		
230	Grab-Archive			230' → 235': Gravelly SAND (gs)	230': Grab - archive
				20% gravel, 80% Sand, tr silt.	
				Gravel predom v. fn peb (basalt) Sand	
				cse to med. 40% basalt/60% qtz/feld;	
235				poorly sorted/mod sorted. Dry, weak	
				HCl rxn.	
				235' → 240': SAND (S)	
				See next page.	
				med-cse sand	
Reported By: L.D. Walker				Reviewed By: CS Walker	
Title: Geologist				Title: Geologist	
Signature: <i>L.D. Walker</i>		Date: 5-10-02		Signature: <i>CS Walker</i>	
				Date: 5/17/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG						Page: 9 of 13	
Well ID: C3926		Well Name: 299-E17-25		Location: 200 E, SW of Purex		Date: 5-10-02	
Project: CY2002 ILAW Drilling				Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:		
	Type & No.	Blows & Recovery					
240	Grab-Archive			Gravel increase ...	Diesel Hammer,		
				240' → 243': Gravelly SAND (GS)	9" by 6" dual wall casing		
				20-30% Gravel, 70-80% Sand.			
				Gravel is fn-v.fn peb; Sand cse	240': Grab sample for archive		
245				243' → 259': Sandy GRAVEL (SG)			
				50% Gravel, 50% Sand, tr silt.			
				Gravel tr med peb, 40% fn peb, 60% v.fn.			
				Sand is cse to v.cse. 50% basalt			
250	Grab-Archive			251': sand very moist, then back to sl moist	250': Grab-archive		
				Gravel SR-SA, poorly sorted,			
				10YR 5/2 (grayish brown) sl moist			
				v. weak HCl rxn.			
				occasional v.cse peb			
255				259' → 275': SAND (S)	260': Grab-archive		
				10% Gravel, 90% Sand.			
				Gravel v. fn peb, Sand predom			
				v.cse to cse. Grayish brown, sl moist, mod to well sorted;			
				SA-SR; 40-50% basalt, 50-60%			
				qtz/feld; very weak HCl rxn.			
260	Grab-Archive						
265							

Reported By: L.D. Walker

Title: Geologist

Signature: [Signature]

Reviewed By: CS Walker

Title: Geologist

Signature: [Signature]

Date: 5-10-02

Date: 5/17/02

BOREHOLE LOG						Page: 10 of 13
Well ID: C3926		Well Name: 299-E17-25		Location: 200 East, SW of Purex		Date: 5-10-02
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:	
	Type & No.	Blows & Recovery			Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level	
270	Grab-Archive			Diesel hammer, 9" by 6" dual wall casing.		
275				270': Grab Sample For archive		
280	Grab-Archive			280': Grab-archive		
285						
290	Grab-Archive			290': Grab-archive		
295						

Reported By: L. D. Walker

Title: Geologist

Signature: L. D. Walker

Reviewed By: CS Whitworth

Title: Geologist

Signature: CS Whitworth

Date: 5-10-02

Date: 5/10/02

Original to: Document and Information Services, H0-09/HWIS

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 11 of 13
					Date: 5/10/02
Well ID: C3926		Well Name: 299-E17-25		Location: 200 East, SW of Purex	
Project: CY 2002 ILAW Drilling			Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
300	Grab-Archive			Sandy GRAVEL (SG) Gravel 75%, Sand 20%, silt 5% Gravel 20% sm. cob, 30% v. cse peb, 30% cse peb, 20% med-fn peb.	Diesel hammer, 9" x 6" dual wall casing 300': Grab-archive
305				Sand predom. med-fn. Dry, poorly sorted; gravel R-SR, Sand SA; Gravel 30-40% basalt, 60-70% qtzite/granitic/other weak HCL rxn	
310	Grab-Archive				310': Grab-archive
315					
					319': End of 5/10/02
320	Grab-Archive				318'→320' Silt content increase sl moist, mod HCL rxn
					320': Grab sample for archive
325					Sandy GRAVEL 75% Gravel, 20% Sand, 5% silt 324'→325': large cobbles slow the drilling rate
					poorly sorted, Gravel cobble to v. fn peb; Sand predom fn - v. fn.
Reported By: L.D. Walker				Reviewed By: C.S. Walker	
Title: Geologist				Title: Geologist	
Signature:		Date: 5-13-02		Signature: Date: 5/17/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 12 of 13	
					Date: 5-13-02	
Well ID: C3926		Well Name: 299-E17-25		Location: 200 East, SW of Purex		
Project: CY 2002 ILAW Drilling		Reference Measuring Point: Ground Surface				
Depth (ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level	
	Type & No.	Blows & Recovery				
330	Grab-Archive			Sandy GRAVEL (SG) 70% Gravel, 20% Sand, 10% silt Gravel 20% cobble, 50% v.cse to cse peb, 30% med-v.fh peb. Sand is med-v.fh 10YR6/2 (lt. brownish gray), dry; poorly sorted; gravel R-SR, Sand SA weak HCL rxn	Diesel hammer, 9" by 6" dual well casing.	
335					330': Grab sample for archive	
340	Grab-Archive				340': Grab-archive	
					341': Gravel is wet sand is med to coarse water produced immediately	
345					345': decrease in water production	
					350' water increase	
350	Grab-Archive				350': Grab-Archive	
					Sandy GRAVEL (SG) 70%, 30% Sand, tr silt. Gravel 10% cobble, 40% v.cse peb, 30% cse peb, 20% med-fh. Sand med to cse; wet, poorly sorted, Gravel R-SR, Sand SA; Gravel 40% basalt, 60% quartzite/granitic Sand 70% qtz / 30% basalt/other	
355						
Reported By: L.D. Walker			Reviewed By: CS Walker			
Title: Geologist			Title: Geologist			
Signature:		Date: 5-13-02	Signature:		Date: 5/12/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 13 of 13
					Date: 5-13-02
Well ID: C3926		Well Name: 299-E17-25		Location: C3926	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
360	Grab-Archive			Sandy GRAVEL (SG) tr-5% 65 % Gravel, 35 % Sand, tr silt.	Diesel hammer, 9" by 6" dual wall casing.
365	diesel hammer			Gravel 20% cobbles (several large basalt cobbles just below 360'), 50% v. cse to cse peb, 30% med- v. fn peb; Sand med to cse; wet; poorly sorted; gravel R-SA ^W SR, Sand SA-Ang; Sand 70% qtz/feld, 30% basalt/other tr mica. Gravel 40% basalt, 60% granitic / qtzite / other	360': Grab Sample for archive
370	Grab-Archive			368': color in water (silt) change from light brown to very dark brown. ⇒ almost black (10YR 2/2)	370': Grab-archive
375				370': Gravel over 80% basalt silt ~ 5% Sand 60% qtz/feld, 40% basalt/other	375': large cob/boulders - slow drilling
380	Grab-Archive			378': water color back to light brown.	380': Grab-archive
				75% Gravel, 25% Sand, tr silt	
				T.D. = 382.5'	With casing shoe at 382.5', water level is 337.2' bgs.
Reported By: L.D. Walker				Reviewed By: C. L. Walker	
Title: Geologist				Title: Geologist	
Signature: L.D. Walker		Date: 5-13-02		Signature: C. L. Walker	
				Date: 5/17/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: <u>1</u> of <u>13</u>
					Date: <u>5-1-02</u>
Well ID: <u>C3828</u>		Well Name: <u>299-E17-24</u>		Location: <u>SW of Purex, on 200E fence</u>	
Project: <u>CY 2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
0				0' → 1.5': Sandy GRAVEL (SG) Crushed rock drill pad.	9" by 6" dual wall casing, diesel hammer
5	Grab-Archive			1.5' → 9': Slightly Silty SAND (lm) S 85-90% Sand, 10-15% Silt. Sand 20% med, 60% fn, 20% v. fn. 10YR 5/3 (brown), sl moist, med sorted, SA; 70% qtz, feld; 30% basalt, weak rxn HCl.	5': Grab sample for archive
10	Grab-Archive			9' → 13': SAND (S) tr-5% gravel, 95-100% Sand Sand v.cse-cse; 10YR 4/1 (dark gray) moist; SA, predom basalt (~90%)	10': Grab-archive
15	Grab-Archive			13' → 33': Slightly Silty SAND tr gravel, 85-90% Sand, 15-10% Silt. 20% v.cse-cse, 50% med, 30% fn-v. fn; 10YR 4/3 (brown), moist; mod sorted, SA-A; 40-50% basalt	15': Grab-archive
20	Grab-Archive			50-60% qtz/feld/other; max size ~10 mm, weak to mod rxn HCl	20': Grab-archive
25	Grab-Archive				25': Grab-archive
				27': trace gravel - med-fn peb.	
				28'-29': tr cobble	
Reported By: <u>L.D. Walker</u>				Reviewed By: <u>C.S. Walker</u>	
Title: <u>Geologist</u>				Title: <u>Geologist</u>	
Signature: <u>[Signature]</u>		Date: <u>5-1-02</u>		Signature: <u>[Signature]</u> Date: <u>5/1/02</u>	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: <u>2</u> of <u>13</u>
					Date: <u>5-1-02</u>
Well ID: <u>C3828</u>		Well Name: <u>299-E17-24</u>		Location: <u>SW of Puvex, on 200E Fence/line</u>	
Project: <u>CY 2002 ILAW Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (FL)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
30	Grab- Archive			Silt content decreasing...	9" by 6" dual wall casing, diesel hammer
				33' → 234' : SAND (S)	
				tr Gravel, 95-100% Sand, tr-5% Silt.	30': Grab sample For archive
35	Grab- Archive			Silt. Gravel SA basalt fn peb, Sand 25% v. cse-cse, 50% med, 25% fn-v. fn. 10YR 5/2 (gry brown)	35': Grab-archive
				S/ moist, salt and pepper appearance, mod sorted, SA-A; 20-30% basalt, 70-80% qtz/other, max size ~ 1 cm, mod rxn HCL	40': Grab-archive
40	Grab- Archive				
					45': Grab-archive
45	Grab- Archive				
					50': Grab-archive
50	Grab- Archive				SAND(S) similar to above trace clumps of silt/clay that show strong HCL rxn tr mica
55	Split Spoon #1	100% rec.			55': Archive collected from SS drive shoe
	Shoe-Grab				
	SS #2				

Reported By: <u>L.D. Walker</u>		Reviewed By: <u>C. Sr. V. 16m</u>	
Title: <u>Geologist</u>		Title: <u>Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>5-1-02</u>	Signature: <u>[Signature]</u>	Date: <u>5/16/02</u>

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 3 of 13
					Date: 5-1-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex, on 200E fence line	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
60	SS #2	100% rec.			58.0' → 62.5': Split Spoon #2
	shoe - Archive			60.5': moisture change from dry to moist - very clear in lexan liner. Possible thin paleosol	60' Archive sample from SS drive shoe
65	Split Spoon #3			SAND (S) 100% Sand with tr silt/clay	62.5' → 67.0': Split Spoon #3
	Shoe - Grab/Archive			67': possible clastic dike fragment in split spoon drive shoe.	65' Archive from SS drive shoe
70	Grab - Archive			→ silt with strong HCl rxn., moist	
					70': Grab sample for archive
75	Grab - Archive			75': tr silt and clay fragments moist	75': Grab - archive
					80': Grab - archive
80	Grab - Archive			SAND (S) similar to above 95-100% Sand, tr-5% Silt	
				20% v.cse, 20% cse, 30% med, 30% Fn-v. Fn; 10YR 5/2 (grayish brown) s/ moist; med sorted, SA; 25% basalt	85': Grab - archive
85	Grab - Archive		75% qtz/feld/other, tr mica; max size ~5 mm; HCl rxn very weak		

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 5-1-02	Signature:	Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 4 of 13
					Date: 5-1-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex, 200E fence line	
Project: CY 2002 ILAW Drilling			Reference Measuring Point: Ground Surface		
Depth (ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
90	Grab-Archive			SAND (S) similar to above 95-100% sand, +- 5% silt. Sand predom med-cse, 10YR 5/2 (grayish brown) moist; SA-A	Diesel hammer 9" by 6" dual wall casing
95	Grab-Archive			15-25% basalt, 75-85% qtz/feld, +- mica, weak rxn HCL.	90': Grab sample for archive
					95': Grab-archive
100	Grab-Archive			Sand med-fn, fragments of yellowish brown (10YR 5/4) silt showing up in drill cyclone. Silt has strong rxn to HCL.	100': Grab-archive
					105': Grab-archive
105	Grab-Archive			105': Sand cse to very cse, 30-40% basalt, no silt.	
					110': Grab-archive
110	Grab-Archive			110': Sand predom med-cse, sl moist	
115	Grab-Archive			115': lumps of moist silt in the sand in cyclone. +- bedding features, less than 1cm thick	115': Grab-archive

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 5-1-02	Signature:	Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: <u>5</u> of <u>13</u>
					Date: <u>5-1-02</u>
Well ID: <u>C3828</u>		Well Name: <u>299-E17-24</u>		Location: <u>SW of Purex, on 200E Fence</u>	
Project: <u>CY 2002 ILAW Drilling</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
120	Grab-Archive			SAND (S) similar to above	Diesel hammer 9" by 6" dia/ wall casing
				Many small silt layers/Fragments	120': Grab sample for archive
125	Grab-Archive			Sand predom med-fn, brown	
				SA-A, 40% basalt 60% qtz/Feld	125': Grab sample for archive
				+ iron oxide staining, moist	
				Silt and clay fragments may be	
				caliche - strong HCL rxn	
130	Grab-Archive			SAND - 100% Sand, med-cse	130': Grab-archive
				130-135': silt fragments	
					135': Grab-archive
135	Grab-Archive				
			SAND (S) 100% Sand, v.cse -		
			med, salt and pepper look, 30-40%		
			basalt, 60-70% qtz/Feld/ other, +		
			mica, 10YR5/2 (grayish brown) moist;	140': Grab-archive	
140	Grab-Archive		SA-A, mod rxn HCL		
			140': silt fragments, small		
				145': Grab-archive	
145	Grab-Archive			145': silt fragments - moist, brown,	
				strong HCL rxn.	
				148': end 5/1/02	
			SAND - moist, 100% Sand, med-cse		
Reported By: <u>L.D. Walker</u>				Reviewed By: <u>C.S. Wright</u>	
Title: <u>Geologist</u>				Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>		Date: <u>5-2-02</u>		Signature: <u>C.S. Wright</u>	
				Date: <u>5/16/02</u>	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 6 of 13
					Date: 5-2-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex, on 200E Fence	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
150	Grab-Archive			SAND (S) similar to above 100% sand, tr silt. Med size, A-SA, 10YR5/3(brown) moist; 20-30% basalt tr mica, mod rxn HCl.	Diesel hammer 9" by 6" dual wall casing
155	Split Spoon #4	80% rec.		Thin (1cm and less) silt/clay layers brown, strong rxn HCl, not horizontal	150': Grab-archive 153.5' → 158.0': Split Spoon #4; PNNL
	Shoe-Archive			Sand similar to above. ⊗ Possible paleosol in liner 155.5' → 157.5'	157.5': Archive from SS drive shoe
160	Split Spoon #5	100% rec.		SAND - 100% Sand, tr silt Predom fn sand, SA; 20% basalt, 80% qtz/other, tr mica; HCl rxn weak to none - tr silt fragments strong HCl rxn	158.0' → 162.5': Split Spoon #5, PNNL 162': Archive
	Shoe-Archive				
165	Split Spoon #6	100% rec.			162.5' → 167.0': Split Spoon #6, PNNL 167': Archive
	Shoe-Archive				
170	Grab-Archive			SAND (S) similar to above 100% sand, tr silt.	170': Archive grab sample
175	Grab-Archive				175': Grab-archive
Reported By: L.D. Walker				Reviewed By: CS. L. W. Burt	
Title: Geologist				Title: Geologist	
Signature: L.D. Walker		Date: 5-2-02		Signature: CS. L. W. Burt	
				Date: 5/16/02	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 7 of 13
					Date: 5-2-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex, 200 E Fence line	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
180	Grab-Archive			SAND - sl moist, predom med.	Diesel hammer, 9" by 6" dual wall casing.
				186 - 187': silty, cemented sand	
				10YR 5/4 (yellowish brown)	
				sl moist, only mod rxn HCL	180': Grab Sample for archive
185	Grab-Archive			20-30% basalt, 70-80% qtz/feld	
				tr mica, SA-A	
				Fragments very firm, difficult to break in hand	185': Grab-archive
190	Grab-Archive			190' - silt fragments, trace	190': Grab-archive
195	Grab-Archive		SAND (S) 100% sand	195': Grab-archive	
			20% v.cse - cse, 60% med, 20% fn - v.fn, tr silt. 10YR 5/2 (grayish brown) sl moist; med-well sorted, SA; 25% basalt, 75% qtz/other, tr mica, max size ~ 2mm (basalt)		
200	Grab-Archive		weak HCL rxn.	200': Grab-archive	
205	Grab-Archive		SAND - as above.	205': Grab-archive	
Reported By: L.D. Walker			Reviewed By: C.S. Wpibut		
Title: Geologist			Title: Geologist		
Signature: <i>L.D. Walker</i>		Date: 5-2-02	Signature: <i>C.S. Wpibut</i>		Date: 5/6/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002).

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: <u>8</u> of <u>13</u>
					Date: <u>5-2-02</u>
Well ID: <u>C3828</u>		Well Name: <u>299-E17-24</u>		Location: <u>SW of Purex, on 200E Fence</u>	
Project: <u>CY 2002 ILAW Drilling</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
210	Grab- Archive			SAND (S) 100% Sand, tr silt predom cse-med; 10 VR6/3 (pale brown) sl moist, mod sorted, A-SA; 20-30% basalt, 70-80% feld/qtz/other, tr mica mod. rxn HCL. max size ~ 2mm	Diesel hammer, 9" by 6" dual wall casing 210': Grab sample for archive.
215	Grab- Archive				215': Grab-archive
				218': tr cemented sand fragments.	
220	Grab- Archive			220': Sand is now dry; otherwise similar to above; cse tr Fm pebbles	220': Grab-archive
225	Grab- Archive			SAND (S) tr gravel (Fm peb) 100% Sand. Med-cse; v-cse by 230 feet. 40% basalt / 60% qtz/other mod sorted, SA-A; max size ~ 1cm, weak HCL rxn; dry	225': Grab-archive 230': Grab-archive
230	Grab- Archive				
				234' → 237': Gravelly SAND (GS) 25-30% Gravel, 70-75% Sand, tr silt.	235': Grab-archive
235	Grab- Archive			Gravel med-v. Fm peb, Sand predom. v-cse. 40-50% basalt, SA-A, poorly sorted/mod sorted	
				back to SAND	
Reported By: <u>L.D. Walker</u>				Reviewed By: <u>C.S. Walker</u>	
Title: <u>Geologist</u>				Title: <u>Geologist</u>	
Signature: <u>L.D. Walker</u>		Date: <u>5-2-02</u>		Signature: <u>C.S. Walker</u>	
				Date: <u>5/16/02</u>	

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BHI-01647

Rev. 0

BOREHOLE LOG					Page: 9 of 13
					Date: 5-2-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex, on 200E Fence	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
240	Grab-Archive			237' → 244': SAND (S) 100% Sand med-cse, 10YR 6/2 (lt. brownish gray), dry; 9" by 6" dual wall mod-well sorted, SA, tr mica; HCl rxn v. weak. casing	Diesel hammer
245	Grab-Archive			244': moisture increase, start Fine pebbles	240': Grab-archive
250	Grab-Archive			244' → 262': Sandy GRAVEL (SG) 40-50% Gravel, 50-60% Sand Gravel is tr. med peb, 40% fn peb, 60% v. fn peb; Sand 50% v. cse, 40% cse, 10% med. Overall color 10YR 5/2 (grayish brown) sl moist to dry; mod sorted; SA; 40% basalt 60% qtz/Feld;	245': Grab-archive
255	Grab-Archive			Sandy GRAVEL - gravel fn to v. fn pebble, Sand is cse to v. cse	250': Grab-archive
260	Grab-Archive				255' Grab-archive
265	Grab-Archive			262' → 277': SAND (S) tr gravel, 100% Sand. Sand is cse to v. cse. grayish brown; dry; mod sorted, SA-A; 30-40% basalt, 60-70% qtz/other; HCl rxn very weak.	260' Grab archive
					265' Grab archive

Reported By: L.D. Walker		Reviewed By: C.S. Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 5-2-02	Signature:	Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20:2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 10 of 13
					Date: 5-2-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex on 200E Fence	
Project: CY 2002 ILAW Drilling		Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:
	Type & No.	Blows & Recovery			
270	Grab-Archive			262' → 277': SAND -as described above	Diesel hammer, 9" by 6" dual wall casing
275	Grab-Archive				270: Grab sample for archive
280	Grab-Archive			277': Sandy GRAVEL 277' → 286': Silty Sandy GRAVEL (msG) 60% Gravel, 20% Sand, 20% Silt Gravel med peb to sm. cob; Sand predom v. fn. dry, weak HCl rxn. -loosing air circulation into formation -cobble fragments	275': Grab-archive 280': Grab-archive 285': Grab-archive
285	Grab-Archive			286' silt content decrease to less than 5%	
290	Grab-Archive			288': large cobbles/or single boulder -qtzite fragments.	290': Grab-archive 292': drill rate increase
295	Grab-Archive			286' → 318': Sandy GRAVEL (sG) 75% Gravel, 25% Sand, tr silt Gravel 30% Cobble/boulder fragments 50% v. cse-cse peb, 20% med-fn peb. Sand cse-med; dry, poorly sorted; gravel R-SR; Basalt, granitic, metamorphic- just about anything; tr silt coating on gravel with v. weak HCl rxn.	295': Grab-archive
Reported By: L.D. Walker			Reviewed By: C.S. Walburn		
Title: Geologist			Title: Geologist		
Signature: <i>L.D. Walker</i>		Date: 5-3-02	Signature: <i>C.S. Walburn</i>		Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 11 of 13
					Date: 5-3-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Purex; 200E fence	
Project: CY 2002 ILAW Drilling			Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
300	Grab-Archive			Sandy GRAVEL (sG) similar to above 75-80% gravel, 20-25% sand, tr silt. Gravel tr lg cobble, 20% sm. cob, 50% v.cse - cse peb, 30% med-fn peb.; Sand mainly fine; dry; poorly sorted; gravel SR, sand SA; largest size ~20cm 30-40% basalt in gravel no rxn HCL	Diesel hammer, 9" by 6" dual wall casing 300': Grab sample for archive 305': Grab-archive 310': Grab-archive 315': Grab-archive 320': Grab-archive 325': Grab-archive
305	Grab-Archive				
310	Grab-Archive				
315	Grab-Archive			sand and silt content increase slightly	
320	Grab-Archive			318' Gravel/cobbles coated with moist silt - light brown, mod-strong HCL rxn 318' → 325': GRAVEL (G) 80-90% Gravel, 10-15% Sand, tr-5% Silt. Gravel predom cse - v.cse peb, tr cobble	
325	Grab-Archive			Sand (v. fn) increase... 325' → 383': Sandy GRAVEL (sG) 60% Gravel, 35% Sand, 5% Silt	
Reported By: L.D. Walker			Reviewed By: C.S. Walker		
Title: Geologist			Title: Geologist		
Signature:		Date: 5-3-02	Signature:		Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG					Page: 12 of 13
					Date: 5-3-02
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Autex on 200E Fence line	
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface	
Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type & No.	Blows & Recovery			
330	Grab- archive			Sandy GRAVEL (SG) 60-8" 70% Gravel, 25-30% Sand, tr-5% silt. Gravel 20% cobble, 40% v.cse peb, 40% cse-Fn peb; Sand is med- v.Fn. 10YR 6/2 (1/4" light brownish gray), dry; poorly sorted; Gravel R- SR, Sand SA; Gravel 25% basalt, 75% qtzite/granitix/other, Sand predom qtz; no rxn HCL.	Diesel hammer, 9" by 6" dual wall casing 330': Grab sample for archive 335': Grab- archive 340': Grab- archive 345': Grab- archive 350': Grab- archive 355': Grab- archive
335	Grab- Archive				
340	Grab- Archive				
345	Grab- Archive				
350	Grab- Archive				
355	Grab- archive				
Reported By: L.D. Walker			Reviewed By: C.S. Walker		
Title: Geologist			Title: Geologist		
Signature:		Date: 5-6-02	Signature:		Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

BHI-EE-183 (02-20-2002)

Appendix B - Borehole Log Sheets

BOREHOLE LOG						Page: 13 of 13	
Well ID: C3828		Well Name: 299-E17-24		Location: SW of Parex on 200E Fence line			
Project: CY 2002 ILAW Drilling				Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments:		
	Type & No.	Blows & Recovery					
360	Grab-Archive			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Maximum Particle Size, Reaction to HCL	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level		
				Sandy GRAVEL (SG)	Diesel hammer, 9" by 6" dual wall casing		
				75% Gravel, 25% Sand, tr silt. Gravel blend of qtzite, basalt, granitic; Sand predom qtz, tr mica. Gravel R-SR, Fr-cse	360': Grab-archive		
365	Grab-Archive			365-366': slow drilling. fragments indist granitic cobbles (lg cob.)	365': Grab sample for archive		
				367': large fragments of basalt.	368': Grab/archive		
	Grab-Archive		367' → 369': One basalt boulder	↳ basalt fragments			
370	Grab-Archive			Below 370', gravel is predom. basalt	370': Grab-archive		
				Sandy GRAVEL (SG)	375': Grab-archive		
375	Grab-Archive			60% Gravel, 40% Sand			
				Gravel tr lg. cob to boulder, 25% sm. cob, 40% v. cse ^{peb.} 35% cse-Fr peb.			
				Sand cse-v.cse; dark gray, wet; poorly sorted, gravel SR, 80% basalt	380': Grab-archive		
				20% qtzite/granitic/other	382': Grab-archive		
380	Grab-Archive			Sand med-cse, 70% qtz, 30% basalt/other	with casing shoe at 383':		
	Grab-Archive				W.L. = 341.3'		
385				TD = 383'			

Reported By: L.D. Walker

Reviewed By: C.S. Wright

Title: Geologist

Title: Geologist

Signature: [Signature]

Date: 5-6-02

Signature: [Signature]

Date: 5/16/02

Original to: Document and Information Services, H0-09/HWIS

APPENDIX C

WELL DEVELOPMENT AND TESTING DATA

Appendix C - Well Development and Testing Data

BHI-01647

Rev. 0

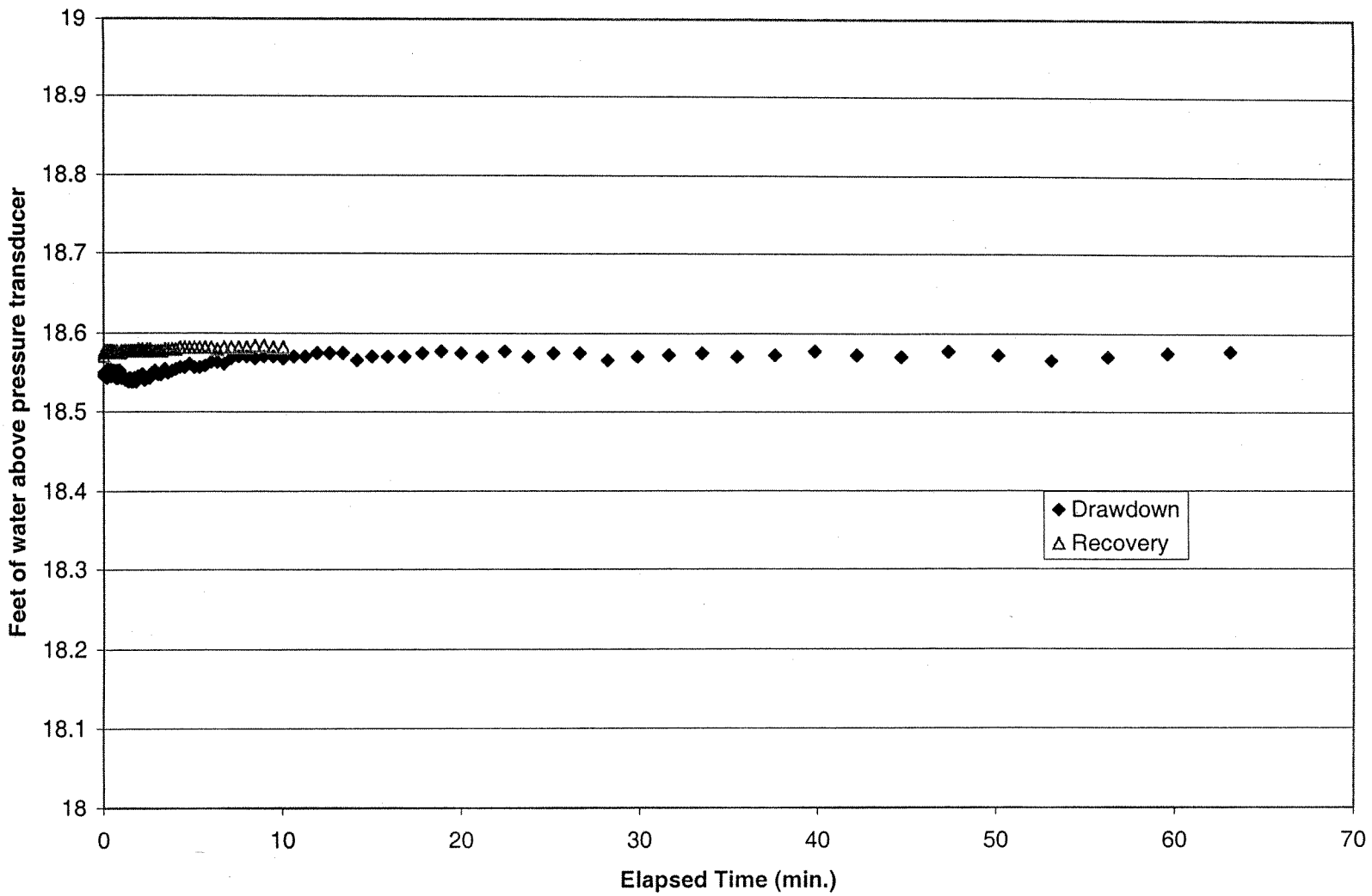
WELL DEVELOPMENT AND TESTING DATA

Well Name: 299-E17-22		Well ID: C 3826	Well Location: SW of Purex / 200E	Date: 5/21/02
Reference Measuring Point (unless otherwise noted): GROUND LEVEL				
Has the well been surveyed? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Does the well have a cement pad? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
PART 1		PART 4		
STATIC WATER LEVEL: <u>TOC</u> Start of Job <u>325.36'</u> End of Job <u>325.30'</u>		<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px;"> Last Recorded Measurements Date: <u>New Well</u> </div> <div style="border: 1px solid black; padding: 5px;"> Current Measurements Date: </div> </div> <p style="text-align: center;">Ground Level</p> <p style="text-align: center;">Cement pad</p> <p>A = _____ A' = <u>2.83'</u> B = <u>NA</u> B' = <u>1.20'</u> C = _____ C' = <u>no landing plate</u></p> <p>Are there any reference marks on the casing strings? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p>		
DEPTH TO BOTTOM: <u>TOC</u> Start of Job <u>362.30'</u> End of Job <u>362.40'</u>				
PART 2				
WELL DEVELOPMENT DATA				
Pump Model <u>Grundfos, 16530-24</u>				
Intake Depth <u>355' (TOC) / 338'</u>				
Starting Turbidity <u>355' 968 NTU</u>				
Pump Start	Stop	Flow Rate		
<u>0813</u>	<u>0920</u>	<u>11 gpm</u>		
<u>0938</u>	<u>1010</u>	<u>13 gpm</u>		
Total Pumped <u>~ 1150 gallons</u>				
Final Turbidity <u>2.66 NTU</u>				
Transducer Range (PSI) <u>10 psi</u>				
PART 3				
INSTANTANEOUS SLUG TEST				
Static Water Level (TOC) <u>NA</u>				
Transducer Depth				
Baseline Start				
Injection Start				
Baseline Start				
Withdrawal Start				
Slug Volume				
Transducer Range (PSI)				
PART 5				
COMMENTS: <u>Initial XD = 18.524 when pump</u> <u>at intake at 355'. No drawdown at</u> <u>11 gpm. Get turbidity to 4.20 NTU.</u> <u>Screen interval ~ 325 → 360' below TOC.</u> <u>Move pump intake up to 338', initial</u> <u>XD = 2.161. Pump at 13 gpm, no drawdown.</u> <u>Turb. down to 2.66 NTU.</u>				

Prepared by (print name): <u>L.D. Walker</u>	Signature: <u>[Signature]</u>
Reviewed by (print name): <u>C.S. Walker</u>	Signature: <u>[Signature]</u>

TO CHECK A BOX: Double click the box; select "Default Value - Checked"

C3826 First Pumping at 11gpm and Recovery (5/21/02)



Appendix C - Well Development and Testing Data

WELL DEVELOPMENT AND TESTING DATA

Well Name: 299-E17-23		Well ID: C3827	Well Location: SW of Purex/200E	Date: 5-20-02
Reference Measuring Point (unless otherwise noted): GROUND LEVEL				
Has the well been surveyed? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Does the well have a cement pad? <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
PART 1		PART 4		
STATIC WATER LEVEL: TOC.		<div style="display: flex; justify-content: space-around;"> <div> <p>Last Recorded Measurements Date: new well</p> </div> <div> <p>Current Measurements Date: 5/20/02</p> </div> </div>		
Start of Job 335.88'				
End of Job 335.82				
DEPTH TO BOTTOM: TOC.				
Start of Job 373.0'				
End of Job 373.10'				
PART 2				
WELL DEVELOPMENT DATA				
Pump Model Grundfos Type 16S30-24				
Intake Depth 369' (TOC) / 355'				
Starting Turbidity > 1000 NTU				
Pump Start	Stop	Flow Rate		
1353	1436	12 gpm		
1453	1525	11 gpm		
Total Pumped 870 gal.		PART 5		
Final Turbidity 4.34		COMMENTS: With pump intake at 369', initial XD = 21.331 ⇒ no drawdown at 12 gpm (XD = 21.316). Turb. down to 4.12 NTU. Raise pump intake to 355' (TOC) initial XD = 7.488. No drawdown (7.441). Turbidity down to 4.34.		
Transducer Range (PSI) 10 PSI				
PART 3				
INSTANTANEOUS SLUG TEST				
Static Water Level (TOC)				
Transducer Depth				
Baseline Start				
Injection Start NA				
Baseline Start				
Withdrawal Start				
Slug Volume				
Transducer Range (PSI)				

Prepared by (print name): L.D. Walker

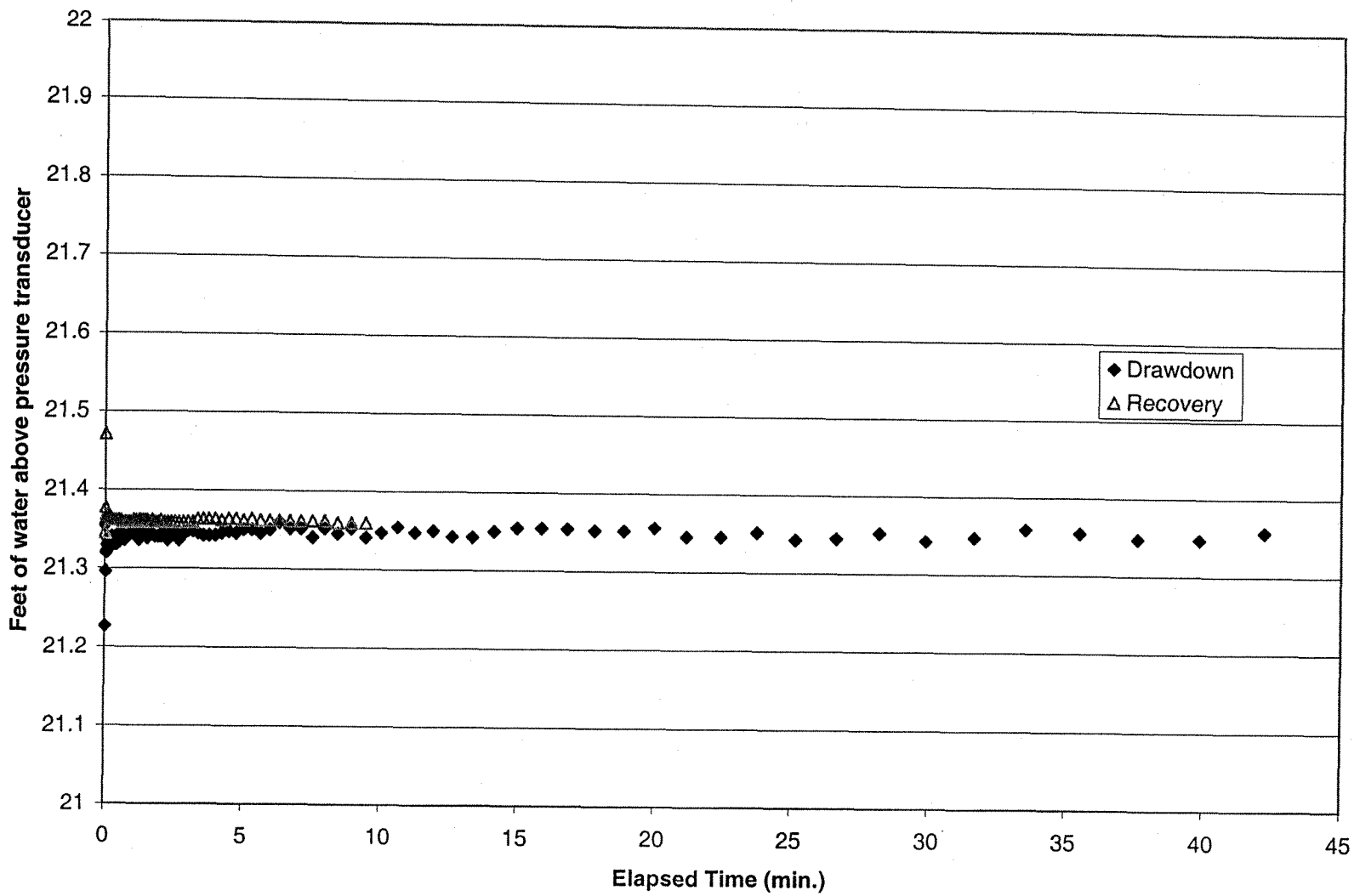
Signature: L.D. Walker

Reviewed by (print name): C.S. Walker

Signature: C.S. Walker

TO CHECK A BOX: Double click the box; select "Default Value - Checked"

C3827 First Pumping at 12gpm and Recovery
(5/20/02)



Appendix C - Well Development and Testing Data

WELL DEVELOPMENT AND TESTING DATA

Well Name: 299-E17-25		Well ID: C3926	Well Location: SW of Purex / 200E	Date: 5-20-02
Reference Measuring Point (unless otherwise noted): GROUND LEVEL				
Has the well been surveyed? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Does the well have a cement pad? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
PART 1		PART 4		
STATIC WATER LEVEL: (TOC)		<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> Last Recorded Measurements Date: NA - New Well </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> Current Measurements Date: </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="width: 45%;"> A = _____ B = _____ C = _____ </div> <div style="width: 45%;"> A' = 2.50' B' = 1.50' C' = (no landing plate) </div> </div>		
Start of Job 340.62'				
End of Job 340.63'				
DEPTH TO BOTTOM:				
Start of Job 376.10'				
End of Job 376.08				
PART 2				
WELL DEVELOPMENT DATA				
Pump Model Grundfos, 16S30-24				
Intake Depth 369 (TOC) / 355'				
Starting Turbidity 41.1 NTU				
Pump Start	Stop	Flow Rate		
0741	0830	11 gpm		
0853	0932	11-12 gpm		
Total Pumped about 1020 gal.		PART 5		
Final Turbidity 4.32		COMMENTS: 12.598 - initial XD.		
Transducer Range (PSI) 10 psi		→ no drawdown at 11 gpm, intake 369' (TOC)		
PART 3		Raise pump NTU down to 3.58.		
INSTANTANEOUS SLUG TEST		Raise pump to 355' (intake)		
Static Water Level (TOC)		Start at ~15 gpm, see XD go from		
Transducer Depth		0.030 to -0.020, then up to		
Baseline Start		~0.050 when flow rate cut back		
Injection Start NA		to 11-12 gpm. Final turbidity 4.32.		
Baseline Start				
Withdrawal Start				
Slug Volume				
Transducer Range (PSI)				

Prepared by (print name): L.D. Walker

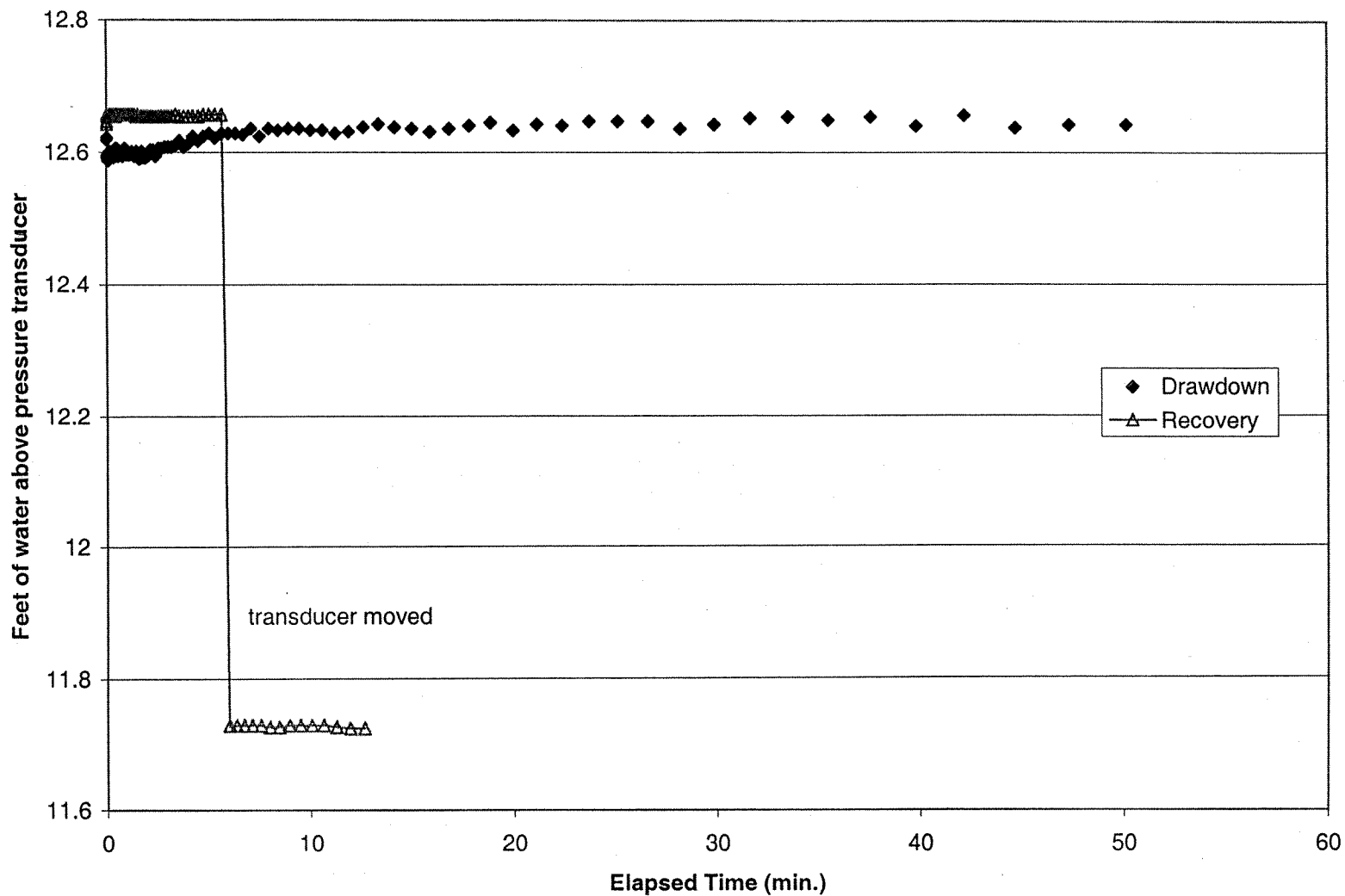
Signature: *L.D. Walker*

Reviewed by (print name): CS Walker

Signature: *CS Walker*

TO CHECK A BOX: Double click the box; select "Default Value - Checked"

C3926 First Pumping at 11gpm and Recovery
(5/20/02)



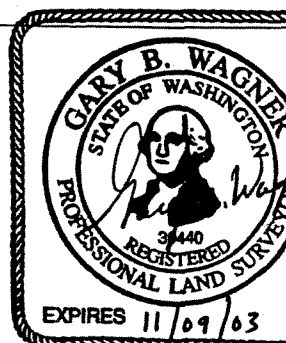
APPENDIX D

SURVEY DATA REPORT SHEETS

Appendix D - Survey Data Report Sheets

BHI-01647

Rev. 0

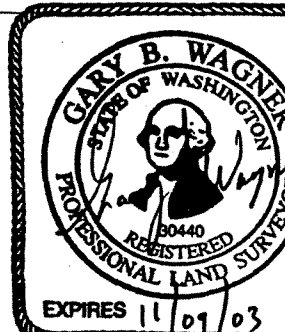
WELL SURVEY DATA REPORT					
ERC Project: 22192			Prepared By: Gary B. Wagner, P.L.S. Company: Rogers Surveying, Inc.		
Date Requested: April 11, 2002			Requestor: Robert Bone		
Date of Survey: May 1, 2002			Surveyor: Rogers Surveying, Inc.		
ERC Point of Contact: Mr. Robert Bone			Survey Co. Point of Contact: Gary B. Wagner, P.L.S.		
Description of Work: Twenty-five Wells in the 100K, 100D & 200West (PFP) Areas of Hanford			Horizontal Datum: NAD83(91)		
			Vertical Datum: NAVD88		
			Units: Metric		
			Hanford Area Designation: 200E		
Coordinate System: Washington State Plane Coordinates (South Zone)					
Horizontal Control Monuments: "PUG" & RSI GPS #36					
Vertical Control Monuments: EXISTING WELL BRASS CAP AT WELL B8500 (299-E17-21) PREVIOUS WELL SURVEY DATA REPORT					
Well Name	Well ID	Easting	Northing	Elevation	
299-E17-22	C3826	574841.090	135195.537		Center of Casing
				221.458	"X" on Rim
		574841.067	135195.921	220.589	Brass Cap
Notes: 					
Surveyor Statement: <i>I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in May, 2002 under my direct supervision, and that the data contained here is true and correct.</i>			Certification Seal 		

BHI-EE-202 (09/98)

Appendix D - Survey Data Report Sheets

BHI-01647

Rev. 0

WELL SURVEY DATA REPORT					
ERC Project: 22192			Prepared By: Gary B. Wagner, P.L.S. Company: Rogers Surveying, Inc.		
Date Requested: April 11, 2002			Requestor: Robert Bone		
Date of Survey: May 1, 2002			Surveyor: Rogers Surveying, Inc.		
ERC Point of Contact: Mr. Robert Bone			Survey Co. Point of Contact: Gary B. Wagner, P.L.S.		
Description of Work: Twenty-five Wells in the 100K, 100D & 200West (PFP) Areas of Hanford			Horizontal Datum: NAD83(91)		
			Vertical Datum: NAVD88		
			Units: Metric		
			Hanford Area Designation: 200E		
Coordinate System: Washington State Plane Coordinates (South Zone)					
Horizontal Control Monuments: "PUG" & RSI GPS #36					
Vertical Control Monuments: EXISTING WELL BRASS CAP AT WELL B8500 (299-E17-21) PREVIOUS WELL SURVEY DATA REPORT					
Well Name	Well ID	Easting	Northing	Elevation	
299-E17-23	C3827	574694.483	134842.439		Center of Casing
				224.659	"X" on Rim
		574694.485	134842.766	223.843	Brass Cap
Notes:					
Surveyor Statement: <i>I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in May, 2002 under my direct supervision, and that the data contained here is true and correct.</i>			Certification Seal 		

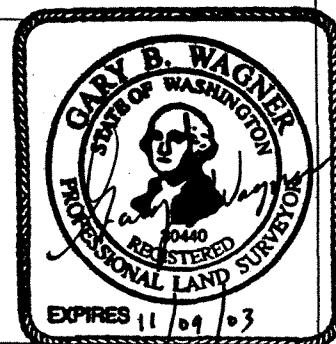
BHI-EE-202 (09/98)

Appendix D - Survey Data Report Sheets

BHI-01647

Rev. 0

WELL SURVEY DATA REPORT					
ERC Project: 22192			Prepared By: Gary B. Wagner, P.L.S. Company: Rogers Surveying, Inc.		
Date Requested: April 11, 2002			Requestor: Robert Bone		
Date of Survey: May 1, 2002			Surveyor: Rogers Surveying, Inc.		
ERC Point of Contact: Mr. Robert Bone			Survey Co. Point of Contact: Gary B. Wagner, P.L.S.		
Description of Work: Twenty-five Wells in the 100K, 100D & 200West (PFP) Areas of Hanford			Horizontal Datum: NAD83(91)		
			Vertical Datum: NAVD88		
			Units: Metric		
			Hanford Area Designation: 200E		
Coordinate System: Washington State Plane Coordinates (South Zone)					
Horizontal Control Monuments: "PUG" & RSI GPS #36					
Vertical Control Monuments: EXISTING WELL BRASS CAP AT WELL B8500 (299-E17-21) PREVIOUS WELL SURVEY DATA REPORT					
Well Name	Well ID	Easting	Northing	Elevation	
299-E17-25	C3926	574515.185	134845.567		Center of Casing
				225.791	"X" on Rim
		574515.171	134845.913	225.028	Brass Cap
Notes:					
Surveyor Statement: <i>I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in May, 2002 under my direct supervision, and that the data contained here is true and correct.</i>			Certification Seal		

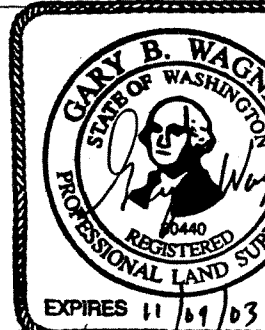


BHI-EE-202 (09/98)

Appendix D - Survey Data Report Sheets

BHI-01647

Rev. 0

WELL SURVEY DATA REPORT					
ERC Project: 22192			Prepared By: Gary B. Wagner, P.L.S. Company: Rogers Surveying, Inc.		
Date Requested: April 11, 2002			Requestor: Robert Bone		
Date of Survey: May 1, 2002			Surveyor: Rogers Surveying, Inc.		
ERC Point of Contact: Mr. Robert Bone			Survey Co. Point of Contact: Gary B. Wagner, P.L.S.		
Description of Work: Twenty-five Wells in the 100K, 100D & 200West (PFP) Areas of Hanford			Horizontal Datum: NAD83(91)		
			Vertical Datum: NAVD88		
			Units: Metric		
			Hanford Area Designation: 200E		
Coordinate System: Washington State Plane Coordinates (South Zone)					
Horizontal Control Monuments: "PUG" & RSI GPS #36					
Vertical Control Monuments: EXISTING WELL BRASS CAP AT WELL B8500 (299-E17-21) PREVIOUS WELL SURVEY DATA REPORT					
Well Name	Well ID	Easting	Northing	Elevation	
ABANDONED	C3828				
		574518.125	134845.545	224.801	BRASS CAP
Notes: C3828 IS AN ABANDONED WELL WITH NO CASING.					
Surveyor Statement: <i>I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in May, 2002 under my direct supervision, and that the data contained here is true and correct.</i>			Certification Seal 		

BHI-EE-202 (09/98)

DISTRIBUTION

ERC Team

K. C. Burgard, CHG	L6-75
L. R. Curry, BHI	H0-09
L. M. Dittmer, BHI	H0-19
K. R. Fecht, BHI (2)	H0-02
T. L. Hottell, BHI	R4-03
R. L. Jackson, BHI	H0-19
F. M. Mann, CHG	H0-22
S. M. Muns, CHI (2)	H9-03
L. C. Swanson, CHI	H9-02
L. D. Walker, CHI	H9-02
C. S. Wright, CHI	H0-19

PNNL

S. Reidel	K6-81
-----------	-------

Document and Information Services (3)	H0-09
DOE-RL Public Reading Room	H2-53
Hanford Technical Library	P8-55

Appendix B

Description of Core from Borehole C3826

Appendix B

Description of Core from Borehole C3826

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
0' to 8'	No core recovered.
8' to 9'	25% recovered—not opened. Moist, loose, no internal structure preserved. Medium- to coarse-grained sand; 75% basalt and 25% felsic; subrounded to subangular; poorly sorted; color 10YR5/2.
9'-10'	55% recovered. Slightly moist, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Coarse to medium-grained sand: 50% coarse, 40% medium-grained, 7% fine-grained, 3% very coarse, with pebbles up to 0.4 in (diameter); well-cemented zone 1.2 to 1.6 in wide (previously wider?) in the middle of the core (at 9'6"); material above this zone is also slightly cemented with CaCO ₃ ; material below this zone is slightly more moist, finer-grained, and shows only a moderate reaction to HCl; 40% basalt and 60% felsic; subangular to subrounded; color 10YR5/2.
10' to 11'	70% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Coarse to very coarse sand: 5-10% gravel, with rounded to subrounded pebbles up to 1 in (diameter), 30% very coarse, 45% coarse, 15% medium-grained, trace of silt; 50% basalt and 50% felsic; subangular to angular; color 10YR5/2.
11' to 12'	95% recovered. Moist, loose, undisturbed. Coarse-grained sand with minor silt, grains up to 0.15 in (diameter); 50-60% basalt and 40-50% felsic; subangular; fairly sorted; color 10YR5/2. At 11'7" is a 0.8-in--thick layer of silt and clay (possible soil?), separating coarse material above from finer material below.
12' to 13'	50% recovered—not opened. Moist, loose, no internal structure preserved. Medium- to coarse-grained sand; 50-70% basalt and 30-50% felsic; subrounded to subangular; poorly sorted; color 10YR5/2.
13' to 14'	75% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Coarse- to medium-grained sand: 45% coarse, 45% medium- and fine-grained, 10% very coarse, with grains up to 0.16 in (diameter); 45% basalt and 55% felsic; angular to subangular (large grains mostly angular); color 10YR5/2.
14' to 15'	95% recovered. Slightly moist, undisturbed, compact. Three color bands apparent. From 14' to 14'2": color band of medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; unsorted. From 14'2" to 14'7.5": fine- to medium-grained sand; compacted, with graded bed fining upwards, each ~0.8 in thick; subangular to subrounded, well-sorted. At the base of this band is a very fine clay zone 0.08 in thick that effervesces. From 14'7.5" to the bottom of the core: coarse sand, with grains up to 0.2 in (diameter); 60% basalt and 40% felsic; subangular; poorly sorted. Color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
15' to 16'	95% recovered. Dry, slightly compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; 10YR5/2. Bands of fine- to medium-grained sand are apparent, and spaced every 1 to 2 in. The most prominent bands are at 15'8" and 15'9". A fairly compact zone is found between 15'6.5" and 15'9.5".
16' to 17'	50% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to fine-grained sand: 55% fine-grained, 40% medium-grained, 5% coarse, 2% very coarse, with grains of basalt up to 0.16 in (diameter); 30-35% basalt and 65-70% felsic; subangular to subrounded; 10YR5/2.
17' to 18'	90 to 95% recovered. Dry, loose, undisturbed. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; 10YR5/2. Pebble layers ~0.5 in thick are found at 17'2.5" and 17'5.5"; both are basalt-dominated, with pebbles up to 1 in (diameter).
18' to 19'	90 to 95% recovered. Dry, uncompacted, slightly disturbed. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; 10YR5/2. Layers of coarser sand present.
19' to 20'	60% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium-grained sand: 75% medium-grained, 10% fine-grained, 10% coarse, 5% very coarse, with granitic pebbles up to 0.1 in (diameter); 30 to 40% basalt and 60 to 70% felsic; angular to subangular; moderately well-sorted; 10YR5/2.
20' to 20'6"	No recovery.
20'6" to 21'6"	30% recovered—not opened. Dry, loosely packed, internal structure not preserved. Medium-grained sand, grains up to 0.15 in (diameter); 50% basalt and 50% felsic; subrounded to subangular; color 10YR5/2.
21'6" to 22'6"	90% recovered. Dry, partially disturbed, uncompacted. Medium- to coarse-grained sand with minor silt, grains up to 0.6 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Some coherent silty nodules present.
22'6" to 23'6"	80% recovered. Dry, disturbed, loose. Medium-grained sand with some silt present; 50% basalt and 50% felsic; subangular to subrounded; poorly sorted; color 10YR5/2.
23'6" to 24'6"	90% recovered. Very slightly moist, loose, undisturbed. Medium- to coarse-grained sand, grains up to 0.15 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; fairly well-sorted; color 10YR5/2. Color band at 23'7" composed of a 0.4-in thick silt-rich (up to 50% silt) layer; effervesces.
24'6" to 25'	No recovery.
25' to 26'	Partially recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand: 58% coarse, 40% medium-grained, 2% very coarse; 50% basalt and 50% felsic; subangular to angular; color 10YR5/2.
26' to 27'	85% recovered. Dry, loose. Medium-grained sand with minor silt; 50% basalt and 50% felsic; subangular to subrounded; poorly sorted; color 10YR5/2.
27' to 28'	85-90% recovered. Dry, loose. Medium- to coarse-grained sand, grains up to 0.07 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. From 17'8.8" to 17'9.5" is a light color band that is finer (contains more silt) than the rest of the core, and is not compact or coherent.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
28' to 29'	Partially recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand: 55% medium-grained, 40% coarse, ~2% very coarse, ~2% fine-grained; 40% basalt and 60% felsic; subangular to angular; moderately well-sorted; color 10YR5/2.
29' to 29'6"	No recovery.
29'6" to 30'6"	80-85% recovered—not opened. Dry, loose, disturbed. Medium- to coarse-grained sand with minor silt; subangular to subrounded; poorly sorted; color 10YR5/2.
30'6" to 31'6"	95% recovered. Dry, undisturbed, well-compacted. From 30'6" to 30'10": calcareous zone, cemented, fine-grained silt to sand with sparse coarse sand, layered; paleosol? From 30'10" to 31'7.5": medium-grained sand with some coarse bands (apparent at 31' and 31'0.5"); 50% basalt and 50% felsic (fine-grained zones are more felsic); subangular to subrounded; well-sorted. From 31'7.5" to 31'8.2": silt layer. Color 10YR5/2
31'6" to 32'6"	100% recovered. Dry, but slightly moist in silty layers, relatively undisturbed. Medium- to coarse-grained sand; 50% basalt and 50% felsic; well-sorted; color 10YR5/2. Coherent layers of silt and sand are at 31'7.1", 31'8", 31'8.8" to 31'11.9", 32'0.5" to 21'1", 32'2.5", and 32'3.5". These layers are silty with sand, and are each ~0.4 in thick. Silty layers are calcareous, as is silt along the core rim, and barely cemented.
32'6" to 33'6"	75% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand: 60% medium-grained, 35% coarse, 5% fine-grained; 40% basalt and 60% felsic; subangular to angular; moderately well-sorted; color 10YR5/2.
33'6" to 34'	No recovery.
34' to 35'	85% recovered. Dry, loose, uncompacted. Coarse to very coarse sand: 30% very coarse, 60% coarse, 10% medium-grained; 50% basalt and 50% felsic; subangular to angular; moderately well-sorted; color 10YR5/2.
35' to 36'	85% recovered. Dry, loose. Coarse sand: 10% very coarse, 80% coarse, 10% medium-grained; 40% basalt and 60% felsic; moderately well-sorted; 10YR5/2 color 10YR5/2.
36' to 37'	90% recovered. Dry, very loose. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well sorted; 10YR5/2 color 10YR5/2.
37' to 38'	85% recovered. Dry, loose, uncompacted. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
38' to 39'	85% recovered. Dry, compacted. Fine- to medium-grained sand; 50% basalt and 50% felsic; well sorted; 10YR5/. Numerous layers of CaCO ₃ -rich zones, from 0.1 to 1.5 in wide. Color 10YR5/2
39' to 40'	90% recovered. Fairly compacted. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well sorted. Layer of silt and CaCO ₃ about 0.4 in thick at 39'5.5" separating darker (more black and fresh?) material above from more brownish-reddish (more clayey and weathered?) material below. Color 10YR5/2
40' to 41'	100% recovered. Intact, not disturbed, well compacted. Medium- to coarse-grained sand with trace of silt; 50% basalt to 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
41' to 42'	90% recovered. Very slightly moist, moderately compact in the middle of core. Medium- to coarse-grained sand: 5% very coarse, 75% coarse, 20% medium-grained. Between top of core and 41'3.1", disturbed and loose, mostly medium-grained sand; between 41'3.1" and 41'6.7" is a fining-upwards sequence (mostly coarse sand between 41'3.1" and 41'4.7", and an obvious band of very coarse sand between 41'4.7" and 41'6.7", with angular to subangular grains up to 0.2 in (diameter); between 41'6.7" and 41'10.6" is another upwards-fining sequence, from medium-grained to medium- and coarse-grained sand; core from 41'10.6" to the bottom is empty. 40 to 50% basalt and 50 to 60% felsic; subangular to angular; moderately well-sorted; color 10YR5/2.
42' to 42'6"	No recovery.
42'6" to 43'6"	60% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand: 30% coarse, 60% medium-grained, 10% very coarse; 40 to 50% basalt and 50 to 60% felsic; subangular to angular; fairly well-sorted; color 10YR5/2.
43'6" to 44'6"	90% recovered. Slightly moist, slightly compact. Coarse sand: 70% coarse, 20% medium-grained, 10% very coarse; possible color bands ~1.2 to 1.6 in wide (upwards-fining sequences from very coarse to medium-grained sand); distinct pebble layer between 43'11.7" and 44'0.6", with grains up to 0.24 in (diameter); 50% basalt and 50% felsic; mostly angular, with some subangular grains; fairly well-sorted; color 10YR5/2.
44'6" to 47'	No recovery.
47' to 48'	90% recovered. Slightly moist, slightly compact. Medium- to coarse-grained sand: 15% very coarse (mainly in the upper half of core, with grains up to 0.1 in diameter), 35% coarse, 50% medium-grained; 40 to 50% basalt and 50 to 60% felsic; angular to subangular; fairly sorted; color 10YR5/2.
48' to 49'	95% recovered. Compact. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well sorted; color 10YR5/2. Silty CaCO ₃ -rich layer from 48'6.7" to 48'8.7".
49' to 50'	80% recovered. Very slightly moist, very slightly compact, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand, with grains up to 0.16 in (diameter); 50% basalt and 50% felsic; angular to subangular; moderately sorted; color 10YR5/2.
50' to 51'	95% recovered. Compact. Medium-grained sand, with basalt clasts up to 0.4 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Some color banding, with basalt-rich layers appearing slightly darker.
51' to 58'	No recovery.
58' to 59'	85% recovered. Loose, uncompacted. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well sorted; color 10YR5/2.
59' to 60'	90% recovered. Loose, uncompacted. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
60' to 61'	85% recovered. Moderately compact. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Color bands and fining-upward sequences 0.4 to 0.8 in thick.
61' to 62'	90% recovered. Compact. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Faint color banding.
62' to 664'6"	Not opened, physical properties testing.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
64'6" to 65'6"	80% recovered. Slightly moist, slightly compact in middle of core, disturbed. (Opened previously for LBL oxygen isotope study.) Fine- to medium-grained sand: 55% medium-grained, 40% fine-grained, 5% coarse; 35 to 40% basalt and 60 to 65% felsic; subangular to angular; well-sorted; color 10YR5/2.
65'6" to 66'6"	Not opened, physical properties testing.
66'6" to 67'6"	90% recovered. Loose, not compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well sorted; color 10YR5/2.
67'6" to 68'	No recovery.
68' to 69'	85% recovered. Not compact. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Contains CaCO ₃ -rich nodules up to 0.8 in (diameter) between 68'2" and 68'4".
69' to 70'	85% recovered. Fairly compact. Between 69' and 69'4", medium-grained sand in 0.2-in-thick bands; from 69'4" to 70' is medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
70' to 71'	90% recovered. Dry, loose, uncompacted. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
71' to 72'	90% recovered. Moderately compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. From 71'7" to 71'9" is a silty layer containing color bands ~0.4 in wide.
72' to 73'	85% recovered. Dry, loose. Medium- to coarse-grained sand; fine- to medium-grained sand with silt between 72'10" and 73'; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
73' to 74'	90% recovered. Moderately compacted. Paleosol? Medium- to fine-grained sand, cemented with CaCO ₃ between 73' and 73'4"; lower part of core is composed of medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
74' to 75'	85% recovered. Loose, uncompacted. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
75' to 76'	95% recovered. Fairly compact. Medium- to coarse-grained sand (mostly coarse), with fining-upwards bands about 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
76' to 76'6"	No recovery.
76'6" to 77'6"	80% recovered. Uncompacted. Uppermost 2.5 in is empty; from 76'8.5" to 77'3" is medium- to fine-grained, CaCO ₃ -cemented sand, poorly sorted; from 77'3" to the bottom of the core is medium- to coarse-grained sand. All material is fairly well-sorted; subangular to subrounded; color 10YR5/2.
77'6" to 78'6"	80% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to coarse-grained sand: 65% medium- to fine-grained; 35% coarse; 30% basalt and 70% felsic; angular to subangular; moderately sorted; color 10YR5/2.
78'6" to 79'6"	95% recovered. Very compact. Medium- to coarse-grained sand, with bands of fining-upwards sequences 1.2 to 1.6 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
79'6" to 80'6"	95% recovered. Well-compacted. Medium- to coarse-grained sand, with subtle fining-upwards sequences ~0.8 in wide each; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
80'6" to 96'	No recovery.
96' to 97'	80% recovered. Slightly moist, uncompacted. Medium- to coarse-grained sand (mainly medium-grained); subangular to subrounded; well-sorted; color 10YR5/2.
97' to 98'	85% recovered. Slightly moist, not compact. Medium- to fine-grained sand, with fining-upward sequences about 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
98' to 99'	85-90% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Medium- to fine-grained sand: 50% medium, 50% fine; 40% basalt and 60% felsic; angular to subangular; well-sorted; color 10YR6/2.
99' to 100'	90% recovered. Moderately compact. Fine- to medium-grained sand between 99' and 99'8.7"; medium- to coarse-grained sand between 99'8.7" to 99'11.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
110' to 119'	No recovery.
119' to 120'	90% recovered. Not compact. One large fining-upward sequence: medium-grained sand in lower part, fine-grained sand in uppermost 2.4 in of core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
120' to 121'	95-100% recovered. Medium-grained sand, with 0.8-in-wide fining-upwards bands apparent; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; 10YR5/2.
121' to 122'	85% recovered. Dry, slightly compact, disturbed. (Opened previously for LBL oxygen isotope study.) Fine to very fine sand, thin (<0.1 in wide) coherent layers visible between 121'2.4" and 121'8.3" of very fine-grained sand between darker, basalt-rich medium-grained layers; 60% fine-grained, 40% medium-grained; very fine-grained loose sand between 121'8.7" and 121'11"; lowermost 1 in of core empty; no HCl reaction; 45% basalt and 55% felsic; well-sorted; color 10YR5/2.
122' to 123'	98% recovered. Compact. From the top of the core to 122'0.6" is fine-grained sand; from 122'0.6" to 122'3.5" is very coarse sand with color banding; from 122'3.5" is a 0.08-in-wide very fine clay layer, iron-stained at the top; from 122'3.5" to 122'10.2" is the top of another fining-upwards sequence, medium-grained sand; from 122'10.2" to 122'11.8" is coarse-grained sand at the bottom of this sequence; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
123' to 149'	No recovery.
149' to 150'	90% recovered. Slightly compact. Medium- to coarse-grained sand, with fining-upwards sequences about 0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. A transition from sand above to more silt below occurs at 149'10.2". Pebbles about 0.8 in (diameter) occur at 149'4".
150' to 151'	90% recovered. Well-compacted. Medium- to coarse-grained sand, some coarse basalt-rich layers fining upwards in layers ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted. Color 10YR5/2
151' to 152'	90% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Sand: 70% medium-grained, 30% fine-grained, coarse layer with grains up to 0.12 in (diameter) between 151'5.5" and 151'5.9"; 40% basalt and 60% felsic; subangular to subrounded; moderately sorted; color 10YR6/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
152' to 153'	90% recovered. Moderately compact. Medium- to fine-grained sand, with subtle fining-upwards sequences ~3.5 in wide; subangular to subrounded; well-sorted; color 10YR5/2.
153' to 163'6"	No recovery.
163'6" to 164'6"	80% recovered. Loose, uncompacted, poorly consolidated. Medium- to fine-grained sand, one fining-upwards sequence; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
164'6" to 165'6"	95 recovered. Compact. Medium- to fine-grained sand, with subtle upward-fining sequences ~2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
165'6" to 166'6"	95% recovered. Compact. Fine- to medium-grained sand, with fining upward sequences ~3 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
166'6" to 167'6"	90% recovery. Moderately compact. Medium- to fine-grained sand; with fining upward sequences ~2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted. The zone between 167'2.5" and 167'2.9" is lined at the top and bottom by brownish silt stringers <0.04 in wide. Color 10YR5/2
167'6" to 168'	No recovery.
168' to 169'	85% recovered. Compact. Mainly medium- to coarse-grained sand; at 168'4.7" is a caliche zone ~1.1 in thick showing soft-sediment deformation, with a lobe protruding 3 to 7.5 in out of the band; at 168'10.6" is a 0.11-in-wide clay layer at the top of an upward-fining sequence; fine sand between 168'10.6" to 168'11.8".
169' to 170'	98% recovered. Well-compacted. Medium- to fine-grained sand, one large fining-upwards sequence; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. Contact between one fining-upwards sequence above and another below at 169'10.6".
170' to 171'	95% recovered. Compact. Medium- to coarse-grained sand, with fining-upward sequences 1-2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
171' to 172'6"	Not opened, physical properties testing.
172'6" to 173'6"	80% recovered. Loose, uncompacted, poorly consolidated. Coarse- to medium-grained sand, mostly coarse, with pebbles up to 0.4 in (diameter) in a layer between 173'0.3" to 173'1.9"; subangular to subrounded; fairly sorted; color 10YR5/2.
173'6" to 174'6"	95% recovered. Compact. Medium- to coarse-grained sand, with fining upwards sequences (coarse to fine) each ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
174'6" to 175'6"	95% recovered. Well-compacted. Medium- to coarse-grained sand, with upward fining sequences ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
175'6" to 176'6"	95% recovered. Compact. Medium- to coarse-grained sand, with color bands of upward-fining sequences about 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
176'6" to 179'	No recovery.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3826
179' to 180'	90% recovered. Moist, moderately compact. Medium- to coarse-grained sand, with fining-upwards sequences ~3.5 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
180' to 181'	95% recovered. Well-compacted. Medium- to coarse-grained sand, with upwards-fining sequences 2 to 2.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. At 180'1.6" is a layer of clay ~0.04 in wide.
181' to 182'	90% recovered. Well-compacted. Medium- to coarse-grained sand, containing fining-upwards sequences mostly ~1 in but up to 5.5 in wide, with 0.4-in-wide sequences within the thicker bands; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
182' to 183'	85% recovered. Dry, loose, disturbed. (Opened previously for LBL oxygen isotope study.) Sand: 75% medium- and fine-grained, 25% coarse; 40% basalt and 60% felsic; subangular to subrounded; moderately well-sorted; color 10YR6/2.
183' to 219'	No recovery.
219' to 220'	95% recovered. Moderately compact. Coarse- to very coarse-grained sand, with a pebbly zone between 219'4.7" and 219'6.3" containing pebbles mainly of basalt up to 0.8 in (diameter); 60% basalt and 40% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
220' to 221'	90% recovered. Compact. Medium- to very coarse-grained sand, with pebbles up to 0.4 in (diameter) and fining-upwards sequences ~3 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
221' to 222'	95% recovered. Compact. Coarse- to very coarse-grained sand, with clasts up to 0.8 in (diameter); coarse basalt-rich bands and upward-fining sequences 2 to 2.5 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Appendix C

Description of Core from Borehole C3827

Appendix C

Description of Core from Borehole C3827

Depth Below Surface (feet and inches)	Description of Core from Borehole C3827
0' to 53.5'	No recovery.
53'6" to 54'6"	45% recovered. Moist, compact. Medium- to coarse-grained sand: 15% very coarse, 30% coarse, 60% medium-grained, with grains up to 0.1 in (diameter); 50% basalt and 50% felsic; angular to subangular; moderately well-sorted; color 10YR5/2.
54'6" to 55'6"	95% recovered. Moist, compact. Medium- to coarse-grained sand, with upwards-fining sequences ~0.8 in wide; 50% basalt and 50% felsic, subangular to subrounded; well-sorted; color 10YR5/2.
55'6" to 56'6"	100% recovered. Moist, compact. Medium- to coarse-grained sand with crude, subtle upwards-fining sequences ~ 2 in wide; medium- to coarse-grained sand between 56'5.4" and 56'5.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2. A fine-grained sand to silt lens between 56'4.2" and 56'5.4" has a 0.04 in layer of clay at the bottom and top.
56'6" to 57'6"	93% recovered. Moist, compact. Coarse sand from top of core to 56'7.8"; very coarse sand between 56'7.8" and 56'11.5"; medium-grained sand between 56'11.5" and 57'0.3", a dark band containing ~60% basalt; continued coarsening downward, from 57'0.3" to 57'5.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
57'6" to 58'	No recovery.
58' to 59'	95% recovered. Moist, moderately compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
59' to 60'	96% recovered. Moist, moderately compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
60' to 61'	99% recovered. Moist, compact. Medium-grained sand from the top of core to 60'6.7", with color bands 0.8 to 1.2 in wide; coarse to very coarse sand between 60'6.7" and 60'9.4", with pebbles up to 0.8 in (diameter) at 60'9.4"; coarse sand between 60'9.4" and bottom of core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
61' to 62'	95% recovered. Slightly moist, compact. Medium- to coarse-grained sand, with upwards-fining sequences (very coarse to medium-grained sand) ~2.8 in wide and pebbles up to 0.6 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
62' to 62'6"	No recovery.
62'6" to 63'6"	95% recovered. Compact. Moist, medium-grained sand from top of core to 62'8"; bioturbated, calcareous paleosol, medium- to fine-grained between 62'8" and 62'11.9"; dry, coarse-grained sand with disseminated CaCO ₃ and pebbles up to 0.2 in (diameter) between 62'11.9" and 63'5". Color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3827
63'6" to 65'6"	Not opened, physical properties testing.
65'6" to 66'6"	92% recovered. Moist, compact. Very coarse-grained sand from the top of core to 65'11.5"; coarse sand between 65'11.5" and the bottom of core; subangular to subrounded; well-sorted; color 10YR5/2.
66'6" to 76'	No recovery.
76' to 77'	100 recovered. Moist, slightly compact (more compact near the bottom of core). Medium- to coarse-grained sand, with faint color banding 0.8 to 1.2 in wide in the bottom half of core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
77' to 78'	100% recovered. Moist, compact. Medium- to coarse-grained sand, with upwards-fining sequences 1.2 to 2.8 in wide; a prominent upwards-fining sequence between 77'7.9" and 77'11.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
78' to 79'	100% recovered. Moist, compact. From the top of core to 78'3.5", coarse to very coarse sand at the top to medium-grained sand at the bottom, with color bands ~0.4 in wide; from 78'3.5" to 78'5.3", a fine sand-silt band; from 78'5.3" to 78'9.1", coarse to very coarse sand; from 78'9.1" to the bottom of core, coarse sand at the top to medium-grained sand at the bottom, with a band of fine material at 78'9.4"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
79' to 80'	95% recovered. Moist, compact. Two prominent fining-upwards sequences: between 79'0.4" and 79'7.7", a sequence of medium- to fine-grained sand; between 79'7.7" and 79'11.8", a sequence of medium- to very fine-grained sand; color banding due to basalt between 79'4.7" and 79'7.5"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
80' to 98'	No recovery.
98' to 99'	95% recovered. Moist, coarse to very coarse sand from the top of core to 98'7"; drier, medium- to coarse-grained sand fining upwards between 98'7" and the bottom of core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
99' to 100'	100% recovered. Slightly moist, compact. Medium-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
100' to 101'	100% recovered. Slightly moist, compact. Fine- to coarse-grained sand, in one large fining-upwards sequence; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
101' to 102'	95% recovered. Slightly moist, well-compacted. Medium- to coarse-grained sand, with a band of finer-grained sand between 101'7.5" and 101'8.7"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
102' to 119'	No recovery.
110' to 120'	100% recovered. Moist, compact. Medium- to coarse-grained sand, with the uppermost 2.8 in of core slightly more coarse, and containing color bands 1.5 to 2 in wide, probably upwards-fining; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
120' to 121'	100% recovered. Slightly moist, compact. Medium- to coarse-grained sand, with color bands ~0.8 in wide and subtle upwards-fining sequences(?); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3827
121' to 122'	100% recovered. Slightly moist, compact. Medium- to coarse-grained sand, with color bands ~0.8 in wide and subtle upwards-fining sequences(?); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
122' to 123'	90% recovered. Slightly moist, compact. Medium- to coarse-grained sand, with color bands ~0.8 in wide and subtle upwards-fining sequences(?); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
123' to 149'	No recovery.
149' to 150'	93% recovered. Dry, slightly compact, fairly loose. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
150' to 151'	90% recovered. Dry, moderately compact. Medium-grained sand, with grains up to 0.2 in (diameter); subangular to subrounded; well-sorted; color 10YR5/2.
151' to 152'	90% recovered. Dry, moderately compact. Medium- to fine-grained sand, with upwards-fining bands ~1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
152' to 153'	90% recovered. Dry, moderately compact. Medium- to fine-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
153' to 153'6"	No recovery.
153'6" to 154'6"	95% recovered. Moderately moist, uncompacted. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
154'6" to 155'6"	95% recovered. Dry, moderately compact. Medium- to coarse-grained sand from the top of core to 154'11.5"; from 154'11.5" to the bottom of core, very coarse sand with pebbles up to 1 in (diameter); most pebbles are found in a layer at 155'3.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
155'6" to 156'6"	95% recovered. Dry, slightly compact. Coarse sand with pebbles up to 0.4 in (diameter) from the top of core to 155'11.5"; medium- to coarse-grained sand between 155'11.5" and 156'5.8"; pebbles up to 1.6 in (diameter) at 156'3.8"; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
156'6" to 157'6"	95% recovered. Dry, slightly compact. Fine- to medium-grained sand, with fining-upwards sequences ~1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
157'6" to 158'	No recovery.
158' to 159'	95% recovered. Dry, slightly compact. Uppermost 1.6 in of core is empty; fine-grained, compact paleosol cemented with CaCO ₃ between 158'1.6" to 158'5.1"; less cemented medium- to fine-grained sand between 158'5.1" and 158'8.7"; from 158'8.7" to the bottom of core, slightly cemented, compact medium- to fine-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
159' to 160'	98% recovered. Moist, compact. Medium- to coarse-grained sand with upwards-fining sequences 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
160' to 161'	97% recovered. Dry, moderately compact. Medium- to fine-grained sand, with fining-upwards sequences ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3827
161' to 162'	96% recovered. Dry, slightly compact. Medium- to fine-grained sand, with fining-upwards sequences (possibly fining-downwards?) 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
162' to 162'6"	No recovery.
162'6" to 163'6"	90-95% recovered. Dry, slightly compact. Fine- to medium-grained sand: 65% fine-grained, 35% medium-grained, trace of coarse sand. From the top: to 162'8" down, disturbed and loose; between 162'7.2" and 162'8" down, possible layer of well-cemented (with CaCO ₃), fine- to very fine-grained sand, but mostly disturbed; between 162'8" and 163'0.9", mainly fine-grained sand with faint color bands 0.8 to 1.6 in wide; between 163'0.9" and 163'4.2", mainly medium-grained sand with faint color bands 0.4 to 0.8 in wide; between 163'4.2" and bottom of core is disturbed and loose. 40% basalt and 60% felsic; subangular to angular; well-sorted; slight HCl reaction; color 10YR6/2.
163'6" to 164'6"	Not opened, physical properties testing.
164'6" to 165'6"	95% recovered. Dry, loose, uncompacted. Medium- to fine-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
165'6" to 166'6"	90% recovered. Dry, moderately compact. Fine- to medium-grained sand, with upwards-fining sequences ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
166'6" to 179'	No recovery.
179' to 180;	95% recovered. Dry, loose. Uppermost 1.2 in of core empty; coarse to very coarse sand between 179'1.2" and 179'2.8"; very coarse sand between 179'2.8" and 179'6.5"; medium- to coarse-grained sand from 179'6.5" to bottom of core; pebbles up to 0.8 in (diameter) in upper 6.5 in of core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
180' to 181'	98% recovered. Dry, compact. Medium- to coarse-grained sand, with color bands (upwards-fining sequences) 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
181' to 182'	96% recovered. Dry, well-compacted. Medium- to coarse-grained sand, with color bands (upwards-fining sequences) 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
182' to 183'	99% recovered. Dry, well-compacted. Medium- to coarse-grained sand, with color bands (upwards-fining sequences) 0.8 to 1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
183' to 219'	No recovery.
219' to 220'	75% recovered. Dry, not compact. Coarse to very coarse sand, with pebbles, mainly of basalt, up to 0.8 in (diameter); 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
220' to 221'	96% recovered. Dry, compact. Uppermost 1.2 in of core is empty; between 220'1.2" to 220'6.3", very coarse sand; between 220'6.3" and 220'7.1", medium- to coarse-grained sand; between 220'7.1" and bottom of core is coarse and very coarse sand; pebbles mostly 0.8 in (diameter) but up to 0.8 in; subtle color bands (fining-upwards sequences) ~1.2 in wide throughout core; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
221' to 222'	95-100% recovered—not opened.

Depth Below Surface (feet and inches)	Description of Core from Borehole C3827
222' to 223'	85% recovered. Dry, moderately compact (especially in lower part of core). Uppermost 0.8 in of core is empty; between 222'0.8" and 222'6.3", very coarse sand, with pebbles up to 0.8 in (diameter), containing a 0.2-in-wide medium-grained sand layer at 222'5.1"; between 222'6.3" and 222'10.6", medium- to coarse-grained sand; core is empty between 222'10.6" and the bottom; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Appendix D

Description of Core from Borehole C3828

Appendix D

Description of Core from Borehole C3828

Depth Below Surface (feet and inches)	Description of Core from Borehole C3828
0' to 53'6"	No recovery.
53'6" to 55'6"	99% recovered. Moist, compact. Medium- to coarse-grained sand, with a 0.2-in-wide silt band at 54'0.7" and subtle upwards-fining sequences ~1.2 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
55'6" to 57'6"	90% recovered. Moist, compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
57'6" to 58'	No recovery.
58' to 60'	95% recovered. Moist, compact. Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
60' to 62'6"	No recovery.
62'6" to 64'6"	97% recovered. Moist, compact. Medium- to coarse-grained sand, with subtle upwards-fining sequences; 50% basalt and 50% felsic; well-sorted; color 10YR5/2.
64'6" to 65'6"	97% recovered. Moist, compact. Medium- to coarse-grained sand, with upwards-fining sequences ~1.1 in wide, scattered pebbles up to 0.8 in (diameter) and a silt layer 0.11 in wide at 65'4"; 50% basalt and 50% felsic; subangular to subrounded; color 10YR5/2.
65'6" to 153'	No recovery.
153' to 155'	60% recovered. Moist. Empty between 153' and 153'9.4"; silt layer from 153'2" to 153'2.4" separating medium- to fine-grained sand below from medium- to coarse-grained sand above; silt lens ~0.4 in wide at 153'11". Medium- to coarse-grained sand; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
155' to 158'	Not opened, physical properties testing. Sample interval 155'6" to 157'6" is compact and contains a clastic dike, 1.2" wide and composed of very fine to fine-grained sand, cutting through medium-grained sand that is 20% basaltic and 80% felsic (light-colored) on one side and 50% basaltic and 50% felsic (dark-colored) on the other side of the dike.
158' to 160'	100% recovered. Moist, compact. Layered: 158' to 158'3.5", silt lens; 158'3.5" to 159'1.8", upwards-fining sequence; 159'1.8" to 159'3", banded layers of finer and coarser material; 159'3" to 159'4.1", band of sand with fine-grained clay at the top and bottom; 159'4.1" to 159'8", upwards-fining sequence; 159'8" to 159'8.3", layer of clay at the top of the lowermost upwards-fining sequence; 159'8.3" to the core bottom, fine- to medium-grained sand. Color 10YR5/2.
160' to 162'	96% recovered. Moist, compact. Medium- to coarse-grained sand, with a possible paleosol between 161'5.7" and 161'9.7" 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
162' to 162'6"	No recovery.
162'6" to 164'6"	100% recovered. Moist, compact. Medium-grained sand, with crude banding ~0.8 in wide; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.
164'6" to 166'6"	96% recovered. Moist, compact. Medium- to fine-grained sand, with subtle upwards-fining sequences; 50% basalt and 50% felsic; subangular to subrounded; well-sorted; color 10YR5/2.

Appendix E

Summary of Spectral Gamma Logging 2002 Immobilized Low Activity Waste Well Installation

Appendix E

Summary of Spectral Gamma Logging 2002 Immobilized Low Activity Waste Well Installation

RG McCain
Stoller – Grand Junction Team

E.1 Introduction

High-resolution spectral gamma logging was performed in three boreholes (299-E17-22, 299-E17-23, and 299-E17-25) in the vicinity of the proposed site for the Immobilized Low Activity Waste (ILAW) disposal site. High-resolution spectral gamma logging provides a total gamma log, as well the distribution of naturally occurring radionuclides (^{40}K , ^{238}U , and ^{232}Th). This information provides some indication as to the nature of the surrounding sediments and is useful for stratigraphic correlation. In addition, any man-made gamma-emitting radionuclides (^{137}Cs , ^{60}Co , $^{152/154}\text{Eu}$, $^{235/238}\text{U}$) that may be present can be identified and quantified.

E.2 Methods

The ILAW boreholes were logged by the spectral gamma logging system (SGLS), which uses a cryogenically cooled high purity germanium (HPGe) detector with an intrinsic efficiency of approximately 35 percent.

With the SGLS, gamma energy spectra are collected in “move-stop-acquire” mode where the detector sonde is held stationary for each measurement and then moved a specified depth increment to the next measurement point. For the ILAW boreholes, a depth increment of 1 ft was used. System gain is adjusted as necessary to maintain a consistent channel relationship for a marker peak (typically the ^{40}K peak at 1461 keV). Typical count times were 200 seconds. Individual gamma energy spectra are recorded using 4096 channels, where channel number is related to gamma energy level. Pre-run and post-run verification measurements are made at the beginning and end of each logging day to provide the channel-to-energy calibration and to assess system performance.

Evaluation of gamma energy spectra provides identification and quantification of naturally occurring and man-made radionuclides on the basis of characteristic energy emissions associated with their decay. Only gamma rays of sufficient energy to penetrate the steel borehole casing and sonde housing can be detected by the SGLS. Radionuclides that emit one or more gamma rays at energies between about 150 and 2,800 keV are detectable with the SGLS. The minimum detection level (MDL) is dependent upon

detector efficiency at the appropriate energy level, background activity, and the yield (gamma rays emitted, on average, per decay). Factors such as casing, water, shielding, and the presence of other radionuclides also have an effect. Tables E.1 and E.2 summarize naturally occurring and man-made radionuclides that can be detected with the SGLS. The terms “primary gamma ray” and “secondary gamma ray” are used to differentiate between the more prominent gamma energy peaks and other, less prominent peaks that may be useful for confirmation. The values indicated in bold are those generally used to calculate concentrations.

Conventional gamma spectra analysis software is used to detect gamma energy peaks, identify the source radionuclide, and determine the net count rate, counting error, and minimum detectable activity. From the net count rate (P_n , cps) for a specific energy peak, the apparent concentration of the source radionuclide (C_a , pCi/g) is determined by:

$$C_a = \frac{27.027}{Y} \times I(E) \times DTC \times K_c \times K_w \times K_s \times P_n,$$

where Y is the radionuclide yield, I(E) is the logging system calibration function, DTC is the dead time correction, and K_c , K_w , and K_s are energy-dependent correction factors for casing, water, and shielding. The calibration function, I(E), is unique for each combination of sonde and logging vehicle. Corrections for dead time and shielding were not applicable to the ILAW data. Values of the calibration function are updated annually and documented in calibration certificates and a calibration report (Koizumi 2002). Concentration error and MDL are calculated from count error and minimum detectable activity using similar equations. The reported concentration error is based on only the estimated counting error. No effort is made to include the effects of errors in the calibration function or correction factors. These errors

Table E.1. Naturally Occurring Gamma-Emitting Radionuclides

Radionuclide	Primary Gamma Rays			Secondary Gamma Rays ^(a)		
	Daughter	E (keV)	Y (%)	Daughter	E (keV)	Y (%)
⁴⁰ K		1460.83	10.67			
²³² Th	²¹² Pb	238.63	43.30	²²⁸ Ac	911.21	26.60
	²⁰⁸ Tl	2614.53	35.64	²²⁸ Ac	968.97	16.17
	²⁰⁸ Tl	583.19	30.36	²²⁸ Ac	338.32	11.25
²³⁸ U ^(b)	²¹⁴ Bi	609.31	44.79	²¹⁴ Pb	295.21	18.50
	²¹⁴ Pb	351.92	35.80	²¹⁴ Bi	1120.29	14.80
	²¹⁴ Bi	1764.49	15.36			
(a) Secondary gamma rays with yields less than 10% are not shown						
(b) Attainment of secular equilibrium between ²³⁸ U and ²¹⁴ Bi/ ²¹⁴ Pb requires long time periods on the order of a million years. Activities of both ²¹⁴ Bi and ²¹⁴ Pb are commonly assumed to be equal to the activity of naturally occurring ²³⁸ U. However, these radionuclides are short-term daughter products of ²²² Rn, and accumulations of radon gas inside the casing may temporarily elevate the decay activities of ²¹⁴ Bi/ ²¹⁴ Pb relative to the decay activity of ²³⁸ U.						

Table E.2. Man-Made Gamma-Emitting Radionuclides

Radionuclide	Half Life (Years)	Primary Gamma Rays		Secondary Gamma Rays	
		E (keV)	Y (%)	E (keV)	Y (%)
⁶⁰ Co	5.2714	1332.50 1173.24	99.98 99.90		
¹⁰⁶ Ru	1.0238	511.86	20.40	621.93	9.93
¹²⁵ Sb	2.7582	427.88	29.60	600.60 635.95 463.37	17.86 11.31 10.49
¹²⁶ Sn	1.E+5	414.50	86.00	666.10 694.80	86.00 82.56
¹³⁴ Cs	2.062	604.70	97.56	795.85	85.44
¹³⁷ Cs	30.07	661.66	85.10		
¹⁵² Eu	13.542	1408.01	20.87	121.78 344.28	28.42 26.58
¹⁵⁴ Eu	8.593	1274.44	35.19	123.07 723.31	40.79 20.22
¹⁵⁵ Eu	4.7611	105.31	21.15		
²³⁵ U	7.038E+08	185.72	57.20	205.31	5.01
^{234m} Pa (²³⁸ U ^(a))	4.47E+09	1001.03	0.84	811.00 766.36	0.51 0.29
²³⁹ Pu	24110	129.30 375.05 413.71	0.0063 0.0016 0.0015		
²⁴¹ Am	432.2	59.54 ^(b)	35.90	102.98 335.37 368.05 662.40 772.01	0.02 0.0005 0.0002 0.0004 0.0002
(a) ^{234m} Pa is a short-term daughter of ²³⁸ U. Secular equilibrium is achieved relatively quickly. Because of the relatively low gamma yield, this peak is not observed when only background levels of naturally occurring ²³⁸ U are present. Hence, the presence of gamma peaks associated with ^{234m} Pa without corresponding peaks associated with ²¹⁴ Pb and ²¹⁴ Bi indicates the presence of chemically processed uranium.					
(b) The 59.54-keV gamma ray may not be detectable in thick casing.					

are discussed in the calibration report (Koizumi 2002). The term “apparent concentration” is used because the calibration model is based on an effectively infinite, homogeneous distribution uniformly distributed about the borehole axis.

The MDL for a radionuclide represents the lowest concentration at which the positive identification of a gamma-ray peak for that radionuclide is statistically defensible. A description of the MDL calculation is included in the data analysis manual (manual in revision).

On the Hanford Site, ¹³⁷Cs is the most commonly detected man-made radionuclide. In routine analysis, spectral regions of interest are “forced” for the 662-KeV peak associated with ¹³⁷Cs, and an

MDL is calculated for each depth, whether or not ^{137}Cs is actually detected. For other man-made radionuclides, MDLs are calculated only when a photon energy peak is detected.

The MDL for ^{137}Cs is typically about 0.2 pCi/g. The MDL differs slightly for each spectrum depending upon count time, background activity and concentrations of other radionuclides at the data point, as well as casing thickness. The MDL for ^{60}Co is about 0.1 pCi/g; the MDL for ^{154}Eu is approximately 0.5 pCi/g; and the MDL for ^{238}U is approximately 14 pCi/g.

Natural and man-made radionuclide concentrations, total gamma count rate, and dead time are plotted as a function of depth. These plots are included in a Log Data Report that also summarizes borehole construction details, logging conditions, analysis notes, and log plot notes, as well as a brief discussion of results and interpretations.

E.3 Results

Log plots for the three ILAW boreholes are included as Figures E.1, E.2 and E.3. The borehole log data were acquired inside a 4-inch diameter stainless steel casing with 0.125-inch wall thickness, which had been installed in the 9-inch diameter borehole. The annular space between the casing and the borehole wall was filled with granular bentonite. This completion method resulted in relatively poor detection conditions for naturally occurring radionuclides. Gamma rays originating in the surrounding formation are attenuated by the annular seal between the casing and the borehole wall, and there is interference with gamma rays originating from natural radionuclides (particularly ^{40}K) in the bentonite, with the result that total gamma activity is somewhat reduced and the use of potassium, uranium and thorium logs for stratigraphic correlation is impaired.

No man-made radionuclides were detected in the ILAW boreholes. Isolated occurrences of ^{137}Cs at the MDL are shown on the log plots, but these are the result of “forcing” a region of interest for the 661.62 KeV peak in each spectra. Examination of individual spectra in which ^{137}Cs appeared to have been detected failed to provide any evidence of an energy peak at 661.62 KeV. These isolated occurrences are most likely the result of statistical fluctuations in the counting process and do not represent credible contamination.

Some difficulties with equipment were encountered during logging. Logging activities began with one SGLS (Gamma 2B) in borehole 299-E17-22, but post-run verification spectra began to fall outside the acceptance criteria. Verification spectra were examined and no immediate cause for the degradation of performance could be determined. Experimental log runs were made with another sonde and it was determined that the source of the problem was most likely in the logging cable or surface data collection system. Repeat logging sections showed significant discrepancies in the ^{232}Th concentration determined from the 2614.53 KeV peak. Comparison of spectra indicated that there appeared to be a loss of efficiency beginning at approximately 2000 KeV, and increasing with increasing energy level. All man-made gamma-emitting radionuclides commonly encountered at Hanford are detected and quantified by gamma rays with energies less than 1500 KeV. Therefore, the degradation of sensitivity experienced by Gamma 2B does not appear to have a significant effect on detection and identification of man-made radionuclides.

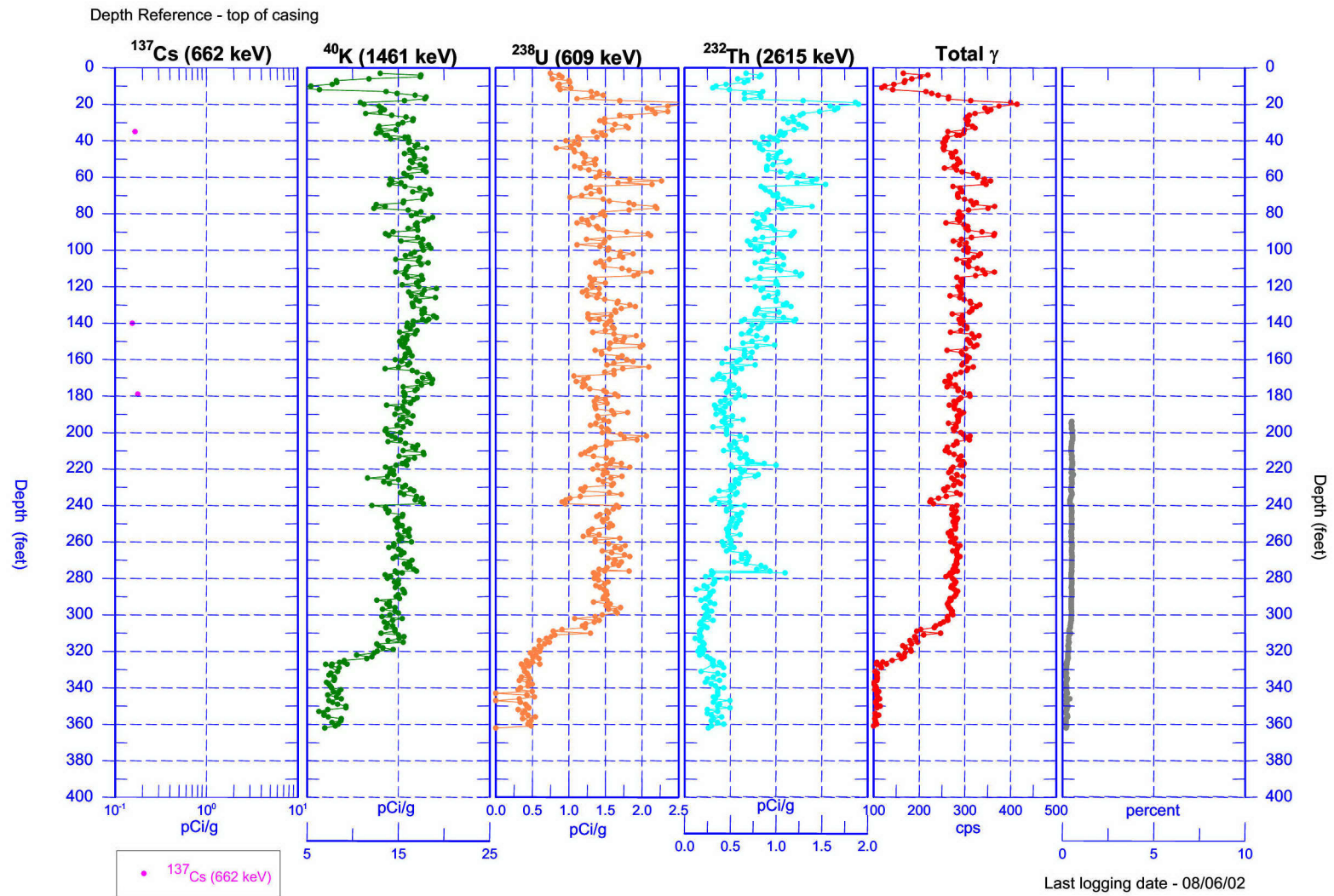


Figure E.1. 299-E17-22 (C3826) Combination Plot

E.6

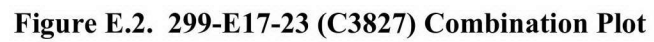


Figure E.2. 299-E17-23 (C3827) Combination Plot

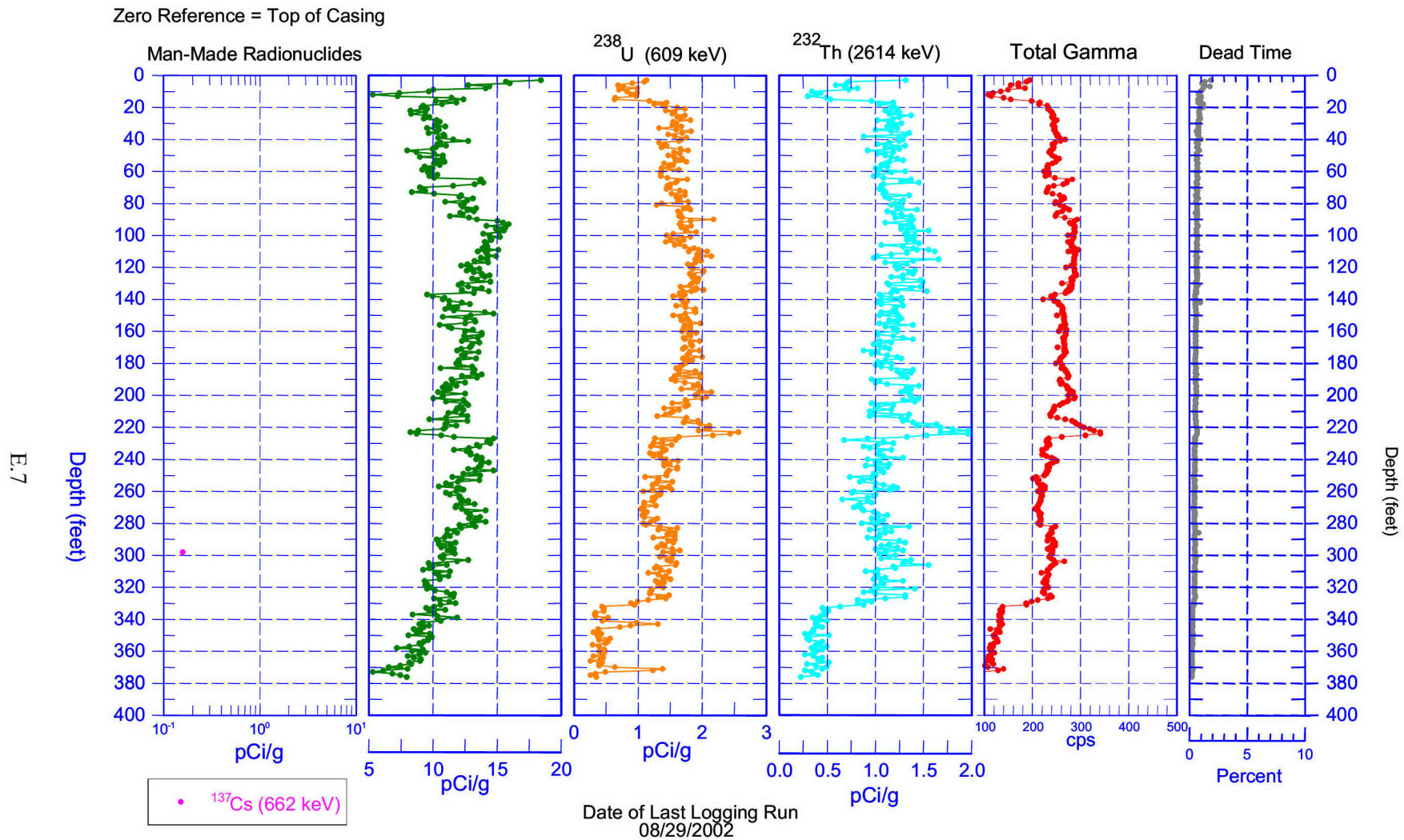


Figure E.3. 299-E17-25 (C3926) Combination Plot

Another SGLS (Gamma 1D) was used to complete logging in 299-E17-22, and to collect data in 299-E17-23 and 299-E17-25.

E.4 Conclusions

Spectral gamma logging in three boreholes at the ILAW site provided plots of total gamma, ^{40}K , ^{238}U , and ^{232}Th as a function of depth. Except for a few scattered false positive indications of ^{137}Cs , no evidence of man-made gamma emitting radionuclides was detected. The annular seal of crushed bentonite (or the sand pack) between the borehole casing and the borehole wall tended to obscure log response, and the usefulness of the logs for stratigraphic correlation was somewhat limited.

E.5 Reference

Koizumi, C. J. 2002. Recalibration of Logging Systems for Characterization of Subsurface Contamination at the Hanford Site; GJO-2002-328-TAR; prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado, April.

Distribution

<u>No. of Copies</u>		<u>No. of Copies</u>	
ONSITE		2	Office of River Protection
5 Fluor Daniel Hanford, Inc.		C. A. Babel	H6-60
		P. E. LaMont	H6-60
B. H. Ford	E6-31		
R. L. Jackson	E6-35	2 Stoller	
G. A. Jewell	A0-21		
L. D. Walker	E6-35	R. G. McCain	B2-62
C. S. Wright	E6-35	S. Sobczyk	B2-62
		Washington State Department of Ecology	
2 Fluor Daniel Northwest Services, Inc.		J. Caggiano	B5-18
R. Khaleel	B4-43		
R. J. Puigh	B4-43	12 Pacific Northwest National Laboratory	
5 CH2M HILL Group		R. W. Bryce	E6-35
		M. J. Fayer	K9-33
D. A. Burbank	L6-75	D. G. Horton	K6-81
K. C. Burgard	L6-75	C. W. Lindenmeier	P8-37
A. J. Knepp	E6-35	C. T. Kincaid	K9-33
F. M. Mann	E6-35	W. J. Martin	K6-81
D. A. Myers	E6-35	B. P. McGrail	K9-81
		P. D. Meyer	BPO
2 DOE Richland Operations Office		R. J. Serne	P8-37
		S. P. Reidel	K6-81
J. G. Morse	A6-38	Hanford Technical Library (2)	P8-55
J. M. Silko	A6-38		